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HOW-TO
DESIGN AND BUILD YOUR DREAM ROBOT
PART 1 INSIDE!

ADOBE PHOTOSHOP ELEMENTS 2023
MAKE YOUR PICTURES PERFECT
LABS TESTED: NVIDIA RTX 4070 Ti + AMD RYZEN 7600 & 7900

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Vigor2865ax

Multi-WAN VDSL2 35b/ADSL2+ router with 1 x configurable GbE WAN/LAN port, 5 x GbE LAN ports, SPI Firewall, 802.11ax (WiFi 6, AX3000) and 32 x VPN tunnels including 16 x OpenVPN/SSL-VPN tunnels

Vigor2927ax

Dual-WAN broadband router with 1 x configurable GbE WAN/LAN port, 5 x GbE LAN ports, SPI Firewall, 802.11ax (WiFi 6, AX3000) and 50 x VPN tunnels Including 25 x OpenVPN/ SSL-VPN

Vigor2765ax

VDSL2 35b/ADSL2+ router with 1 x configurable GbE WAN/LAN port, 3 x GbE LAN ports, SPI Firewall, 802.11ax (WiFi 6, AX3000), and 2 x VPN Tunnels including 2 x OpenVPN/SSL-VPN tunnels

Vigor2135ax

Gigabit broadband router with 4 x GbE LAN ports, 802.11ax (WiFi 6, AX3000), and 2 x VPN tunnels including 2 x OpenVPN/SSL-VPN tunnels

i-LAN TECHNOLOGY

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EDITORIAL

WHAT'S INSIDE *APC*

AUSTRALIAN
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EXCELLENCE AWARD - WINNER 2022
FOR THE PERSON, PRODUCT OR TECHNOLOGY THAT ADVANCED THE PC MORE THAN ANY OTHER IN 2022
AUSTRALIAN
PC AWARDS
EPIC FAIL - WINNER 2022
2022'S BIGGEST LOSER

EDITORIAL

Winners

And losers

BEN MANSILL
Loves hearing from readers about which bits of *APC* are excellent, and what isn't.

It's Awards time folks! That magical time of the year when the editorial team here sits down in a room with Diet Coke and biscuits, the big boss here bricks up the door, and we then argue for several days, ultimately concluding with a list of things that are more excellent than the rest. This year's session went quite well, and it was generally peaceful agreement on all counts. It's been a banner year for tech, so it really wasn't hard tapping what shone brightest.

You can read about all the finalists, highly commended and ultimate winners in the next issue of *APC*, when we reveal all.

It wasn't just a banner year for great tech and products, either. Over the days that we examined all potential finalists, it became very clear that 2022 was also an outstanding year for things that failed hard. Remarkably so, in fact. Thus it has been decided to add a new Award category for things that failed, disappointed after much promise, or was just a bad idea, poorly executed. We have imaginatively called this category Epic Fail – bringing back into common use that old phrase that was popular a decade ago. That's how we roll.

So as a bit of a teaser, I'm sharing the Epic Fail finalists, and along with that to add some balance, the list of finalists for our Excellence award. What a contrast, eh? Absolutely every finalist on both lists belongs, and it all makes it very clear that 2022 was truly rare and special.

EXCELLENCE AWARD FINALISTS:

- AMD Ryzen 5800X3D / V-Cache
- Nvidia RTX 4090
- Nvidia DLSS 3
- QD OLED monitors
- Apple M2 CPU
- Wi-Fi 6E
- 10GbE LAN
- Intel 12th-Gen mobile CPUs
- Microsoft PC Game Pass
- Chiplet GPU
- Apple M1 Ultra

EPIC FAIL FINALISTS:

- NFTs
- The Metaverse
- GPU pricing and availability
- Optus & Medibank hacks
- Elon Musk
- No Steam Deck in Australia yet
- Google Stadia
- Crypto currency
- Nvidia RTX 4080 12GB Unlaunching

See what you liked – or hated – from both lists, and next issue we'll share it all, along with all the other categories for tech and PC gear distilled down from hundreds of potential winners. Quite exciting, all this. See you then.

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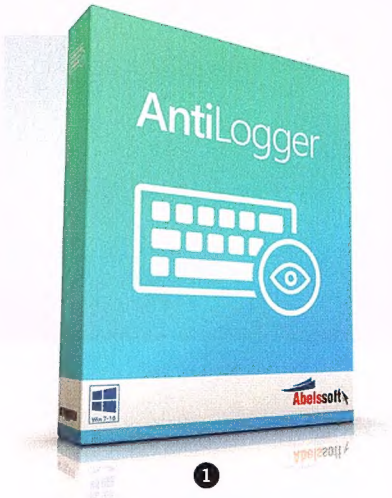

❶

ABELSSOFT ANTILOGGER

Stop hackers recording your keystrokes.

It's important to protect one's self from loggers. Abelssoft presents for this purpose the newly developed Antilogger. This Windows application runs constantly and invisibly in the background, monitoring one's computer. Its purpose is to immediately detect the presence of loggers and then use an alarm to instantly alert the user. In the program the user can view a list of processes running on their computer, and see if any are potentially loggers. Suspicious processes can easily be stopped immediately and permanently. Benign processes falsely identified as malicious loggers will be placed on a "non-malicious software" list to prevent any further false alarms.

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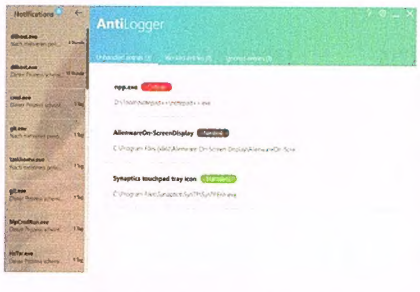

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ASCOMP F-RENAME

Quickly and easily rename files.

DSC813913091.JPG, 20110920.AVI, DL_MUSICFILE.MP3 – every computer user knows them: meaningless file names, generated by the digital camera, smartphone or download manager. F-Rename brings light into the data dark and renames any number of files according to freely selectable patterns. It's easy to apply different pre-made renaming patterns or individual patterns. Number or date entire file collections and name your MP3 files with just a few mouse clicks based on ID3 tags. The individual renaming function offers the highest possible flexibility. Not only does it allow you to use many tags, but it also helps to convert, shorten, and partially or completely replace existing file names.

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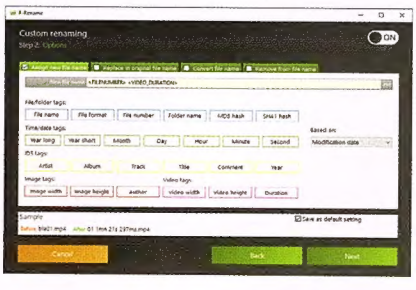

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ASHAMPOO PHOTO OPTIMIZER 2022

Image editing at the click of a button.

Ashampoo Photo Optimizer 2022 is the simple and fastest way to edit photos in a single click. Photos are auto-analysed and all potential weaknesses regarding lighting, colour temperature and contrasts detected. Afterwards, a special algorithm recreates each photo with optimal results. Even mediocre shots will suddenly appear more vibrant and harmonious. Common issues like lack of contrast or noise are also fixed in one go. But no photo editor would be complete without the classic features like colour, brightness, contrast, and gamma manipulation. You can also freely crop, rotate and resize your photos.

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AMD RADEON RX 7900 XTX | SAPPHIRE NITRO+

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SAPPHIRE NITRO+ AMD Radeon™ RX 7900 XTX Graphics Card

At the core of SAPPHIRE NITRO+ Graphics Card are the technologies of the NITRO+ House of PANTHEON. PANTHEON guarantees supreme cooling technology and many distinct features with each NITRO+ iconic feature standing as strong as the pillars of the PANTHEON.

SAPPHIRE NITRO+ sounds the call to battle and is every opponents worst enemy. The long-feared beast of Heat and the dreaded titan of Noise rise from the depths at every chance they can get. SAPPHIRE NITRO+ once again takes on the quest of saving the PC Gaming World and taming these feared monsters. And thus, the legendary NITRO+ House of PANTHEON was constructed to protect every NITRO+ Graphics Card, taming the monsters Heat & raging Noise. Deep in the forges of this prodigious structure, the legendary pillars of PANTHEON are churned out. Spinning a commanding air vortex to dissipate Heat. Formidable structural components for quality of life and durability. Hardware features engineered to keep NITRO+ running strong and effective. Software integrations to battle Heat & Noise but also customize PANTHEON to the way you like. Personalize NITRO+ PANTHEON to the legendary house you imagine for your SAPPHIRE NITRO+ Graphics Card.

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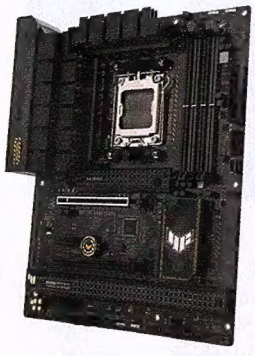

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HOW WE DO IT

Inside *APC*

Find out all about APC's editorial policies, test practices, how to read the benchmark results, and more.

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"Championing technology doesn't mean we're unrelenting yes-men and -women, however, and *APC* aims to be as objective as possible in all our coverage."

APC is Australia's oldest consumer technology magazine – having been consistently in print for over forty years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech, too, from smartphones and apps to peripherals, accessories, and beyond. We have two goals: to find the best modern tech and to help you make the most of it.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And, like you, *APC*'s journalists want to know what's good in tech – no matter what platform it resides on.

Independent reviews

Championing technology doesn't mean we're unrelenting yes-men and -women, however, and *APC* aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three attributes.

As a matter of policy, reviews published in *APC* are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an *APC* reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

Labs testing

APC strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance including storage read and write speeds, gaming and battery life.

In most cases, for the benchmark results published in *APC*, you can assume that higher is better. There are certain tests that deviate from this rule where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter offers better ease-of-readability, but tables are more compact, so we use these in most cases where thoroughness is preferred.

UPDATED FOR 2023

apc TESTBED

The current APC testbed used in the Labs for benchmarking all components. This testbed is updated as new and relevant technology comes on stream.

CPU	Intel Core i9 12900K
Motherboard	Asus Maximus Z690 Apex
Graphics Card	Nvidia GeForce RTX 4090 Founders Edition
RAM	2x16GB G.Skill Trident Z5 DDR5-6000
Power Supply	Corsair AX1000
Storage	Seagate Firecuda 530 2TB
Case	Thermaltake Core P8
Cooling	Cooler Master Flux PL360 AIO
Operating system	Windows 11 Pro 22H2

apc AWARDS

apc EDITOR'S CHOICE

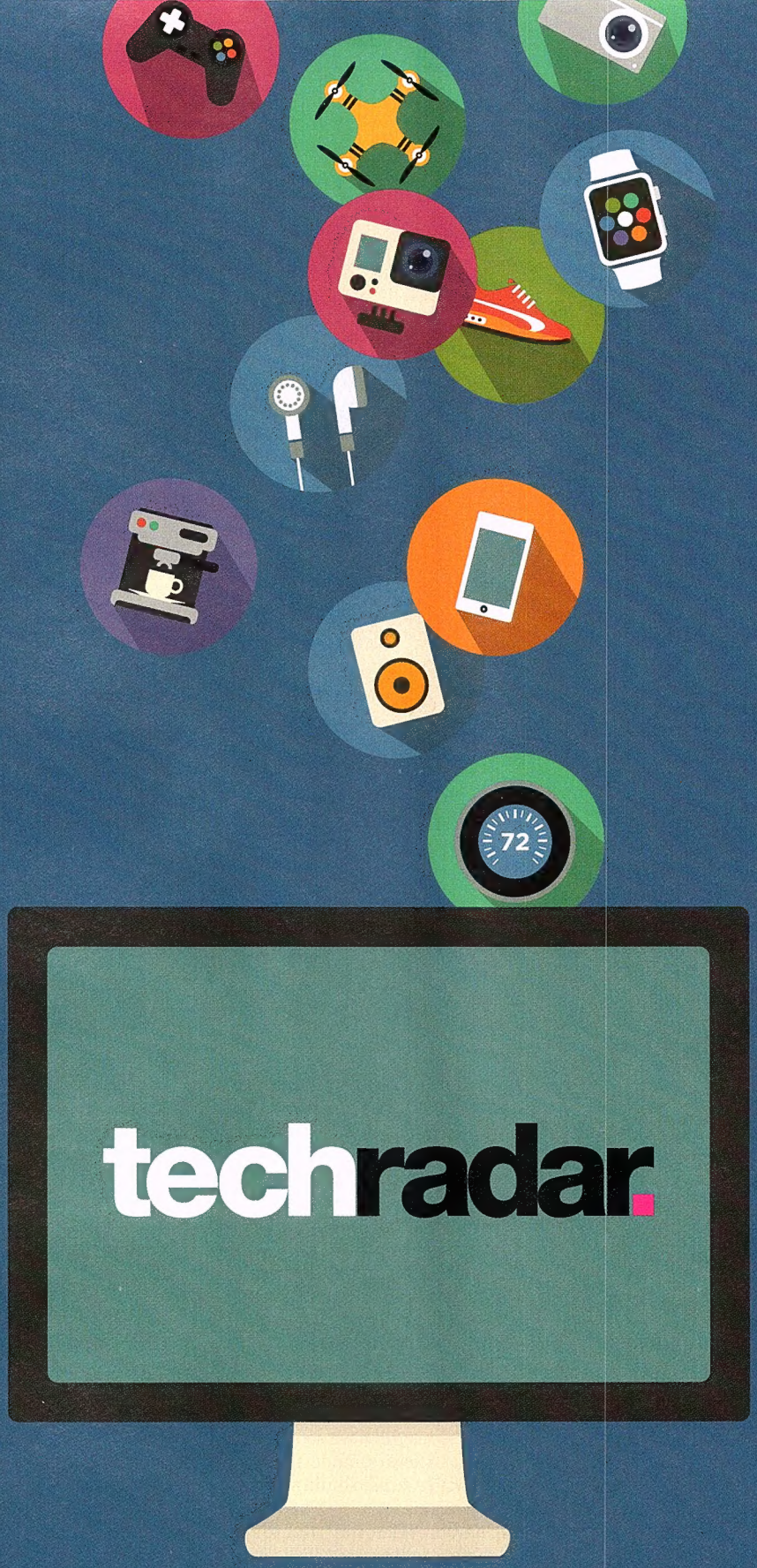
APC EDITOR'S CHOICE

When a product scores 4.5 out of 5, it carries the Editor's Choice Award. These are products that exceed expectations and deliver a quality experience up there with the very best.

apc HIGHLY RECOMMENDED

APC HIGHLY RECOMMENDED

You will see this award if a reviewed product has scored four out of five stars. It means most people can expect satisfying performance from the product, and that we would use it ourselves.



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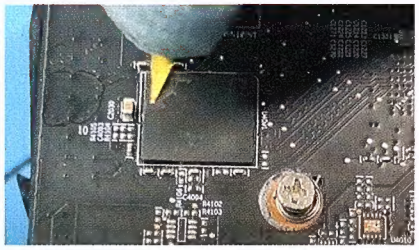

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CRYPTO MINERS SELLING REPAINTED GPUS 'AS NEW'

Be careful who you buy from.

Some Chinese crypto miners are doing everything they can to offload their heavily used mining GPUs now that they've nothing left to mine. They are going to interesting lengths to sell their inventory, like repainting them and listing them as new on some retail sites. An investigation by Youtuber Iskandar Souza and Paulo Gomes claims that some third-party retailers are selling GPUs that appear new but have been touched up to hide the fact that they were used for crypto mining. The easiest method to tell if it's had this treatment is to look for a yellow tint on the memory on the GPU, which is caused by one of two ways; prolonged use or they've been resoldered onto newer boards.

© Western Digital

WD LAUNCHES DUAL-ACTUATOR 20TB HDDS

Speedy SATA SSD-like throughput.

In a rather unexpected move, Western Digital introduced its first dual actuator hard disk drives, matching its competitor Seagate's impressive Exos drives that use similar tech. The dual actuator Ultrastar DC HS760 20TB HDD builds upon the proven single-actuator Ultrastar DC HC560 drive, but doubles its sequential read/write speeds to the types of speeds we see with SATA SSDs and also nearly doubles its random read/write performance. Two independent actuators in the drive work in parallel, offering up twice the sequential throughput (up to 582 MB/s), which is on par with a SATA SSD in throughput, and 1.7X higher random performance than a single-actuator HDD. Western Digital does not disclose the pricing of its dual actuator HDDs, but they will naturally be more expensive than single-actuator hard drives.

AI

Microsoft pours billions into ChatGPT

Microsoft see AI as the future of computing.

Microsoft is stepping up its investment in the artificial intelligence realm, and has announced it is expanding its partnership with OpenAI. According to Microsoft, this will be the third phase in its tie-up with OpenAI, representing a "multi-billion dollar investment" in its effort to be at the forefront of all things AI.

"We formed our partnership with OpenAI around a shared ambition to responsibly advance cutting-edge AI research and democratise AI as a new technology platform," said Microsoft CEO Satya Nadella. "In this next phase of our partnership, developers and organisations across industries will have access to the best AI infrastructure, models, and toolchain with Azure to build and run their applications."

From now on, Microsoft's Azure cloud infrastructure will be used exclusively to power OpenAI workloads, API services, research, and backend systems. Microsoft will also use OpenAI to enhance its products to create "new categories of digital experiences." Those experiences will leverage OpenAI's ChatGPT, a conversational AI routine that can be used to write articles, poetry, and even debug code.

It has been reported that Microsoft plans to fuse ChatGPT with its Bing search engine to become more competitive with Google (or, more specifically, the Google Knowledge Graph). Perhaps even more interesting is the rumour that claims Microsoft intends to bring the GPT text-generation model to Microsoft Word and Outlook. This would potentially let AI write emails for you based on input commands, or flesh out an article you're writing using information siphoned from the web.

Microsoft's investment in AI should not come as a surprise to anyone. When Nadella announced that the company would lay off 10,000 employees this year, he noted that "the next major wave of computing is being born with advances in AI, as we're turning the world's most advanced models into a new computing platform."

OpenAI was co-founded in 2015 by a group of tech luminaries, including Sam Altman, Peter Thiel, and Elon Musk. Its mission is to "ensure that artificial general intelligence benefits all of humanity," and the company's continued partnership with Microsoft will hopefully advance those efforts.

"The past three years of our partnership have been great," said Altman, who serves as OpenAI's CEO. "Microsoft shares our values and we are excited to continue our independent research and work toward creating advanced AI that benefits everyone."

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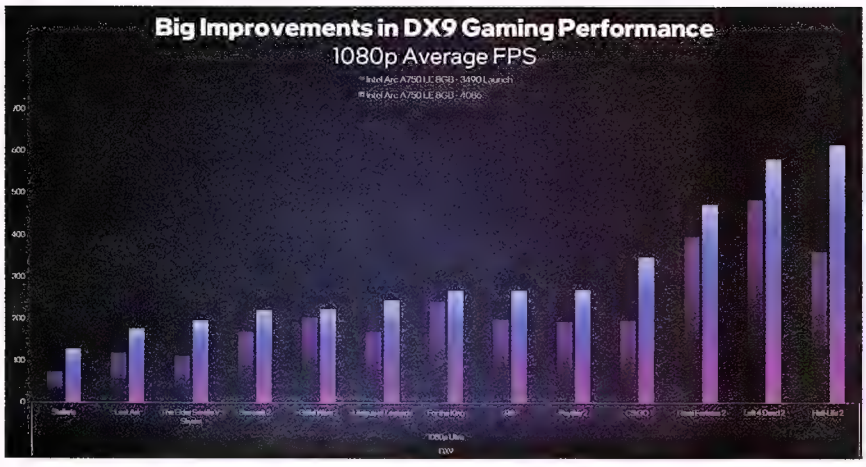

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Intel Arc price down, performance up

DX9 performance has increased by 43% since launch.

The Intel Arc Alchemist architecture brought a third competitor to the best graphics cards, and while it can't top the GPU benchmarks in terms of performance, there's certainly a strong value proposition. At the same time, there are areas where the drivers still need tuning. Intel hopes to encourage further adoption with the latest announcement of a price cut to the Intel Arc A750, bringing it down to just US$250 (~AU$350, though the cheapest at the time of writing is $369).

It's not just about lowering the price, either. Since launching with the 3490 drivers back in October 2022, Intel has delivered three WHQL drivers and at least four beta drivers, and improving performance and compatibility has been a key target for all of the driver updates.

DirectX 9 performance, an area that Intel hadn't really focused on prior to the Arc launch, has been one of the biggest benefactors of the newer drivers. Intel claims that, across a test suite of thirteen games, average framerates at 1080p have improved by 43 percent, and 99th percentile fps has improved by 60 percent. At 1440p, the average fps increased by 35 percent while 99th percentile fps improved by 52 percent.

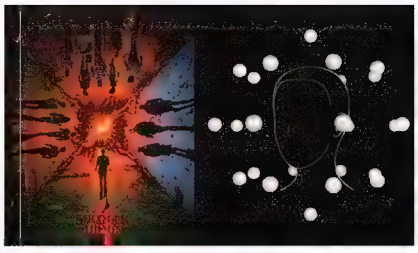
© xxx

AMD RDNA 3 APPEARS PRIMED FOR 3D V-CACHE INTEGRATION

Could make its way into a mid-cycle refresh.

With the announcement of AMD Ryzen 7000X3D-series chips at CES 2023, a lot of attention has been paid to the new stackable cache technology.

There is reason to hope that this same technology will be making its way to some AMD graphics cards. It has long been rumoured that AMD would be bringing 3D V-cache to its GPUs after successfully implementing it in its Ryzen 5800X3D processor. The idea behind V-cache is to use a hybrid bonding technique to put a slab of cache memory on top of the compute cores of a processor. This can greatly expand the amount of cache available, which saves the processor critical clock cycles since it doesn't have to go further out to regular memory to fetch data or instructions.



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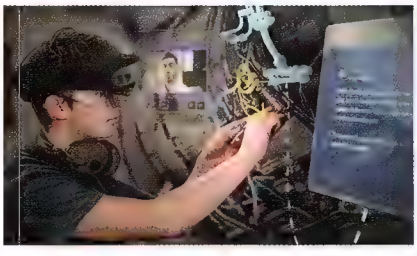
NETFLIX UNLEASHES MAJOR AUDIO QUALITY UPGRADE

Spatial surround with stereo speakers.

Netflix has announced a series of brand-new features for members on its Premium plan, including Netflix spatial audio. Members on Netflix's Premium plan using a stereo system can experience immersive cinematic audio on more than 700 top titles using their existing hardware. Netflix spatial audio is powered by Sennheiser's AMBEO 2-Channel Spatial Audio technology. Developed in partnership with Netflix, this Sennheiser technology delivers an immersive experience over stereo speakers while respecting the creative intent of the original surround or immersive mix. Netflix members do not need any additional hardware to experience this new benefit. In addition to content mixed for Dolby Atmos, Netflix's spatial audio catalogue will also include non-Atmos surround content.



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MICROSOFT'S LAYOFFS INDICATE XR AMBITIONS ABANDONED

Entire teams behind projects have lost their jobs.

Microsoft's recent 10,000 layoffs were significant, even for an employer the size of Microsoft, with the numbers representing nearly five percent of its entire workforce, or one job in twenty. Teams behind projects like HoloLens, AltSpaceVR, and MRTK (Mixed Reality Tool Kit) have all been layed off, as well as teams behind projects like HoloLens, AltSpaceVR, and MRTK (Mixed Reality Tool Kit) have also been culled in their entirety. With regards to HoloLens, we know it has already been refocused and scaled back a number of times. Its chief architect Alex Kipman left a few months ago. Are we witnessing another Windows Phone moment for Microsoft, a strategic withdrawal signalling it has lost too much ground to competitors to have the heart to compete? ■

TECH BRIEF

Intel faces down the deepfakes

Blood-flow breakthrough could scupper the AI-generated frauds.

AI-generated fake videos featuring familiar faces – deepfakes – have the potential to scramble our perception of what is real. But as the technology has improved and refined, the deepfake detectors have been fighting back. Now, Intel has invented what may be a significant step forward in helping us separate the living, breathing humans from the AI-puppets.

Intel calls its creation FakeCatcher, and it works by taking a very close look at the blood flow in our faces, using a technique that is known as photoplethysmography – or PPG for short.

"I said, there should be some priors that we can trust in real videos. What are those priors?" said Dr Ilke Demir, senior staff research scientist at Intel Labs, who invented the system.

"And then I saw an MIT paper about finding blood flow from videos."

"We first find the face and, from the face, we find the facial landmarks," said Demir. "From the facial landmarks, we extract the region of interest."

The system then uses Intel's OpenVino deep learning toolkit to correct for geometry – overlaying a grid on the face to carefully analyse the minute changes in colours of blood vessels under the skin, every 64 or 128 frames. "From each grid cell, we extract the PPG signal," said Demir, explaining how PPG is a particularly effective tell that a human is real, because deepfake software cannot yet correct for PPG.

"It is such a subtle signal that is correlated everywhere on our face. So, it is almost impossible to replicate," she said.

According to Intel, the FakeCatcher system is so robust that it can detect deepfakes in 96 percent of cases, and in real time.

Consequently, it's conceivable that a future videoconferencing software will be able to pop-up a warning if it believes that you are speaking to a fraudster.

> "According to Intel, the FakeCatcher system is so robust that it can detect deepfakes in 96 percent of cases, and in real time."

It even works if the faker tries to be clever and get around it by turning on a face-smoothing filter, for example. "The smoothing operator is actually a linear operator," said Demir. "So even if you smooth your face, the signals are still correlated for the real video." Even though a smoothed face might have a different PPG score for each cheek, the two figures will still be correlated on a real video – so even if our cheeks are read as different colours, the difference between the two should remain fixed.

It seems beating FakeCatcher is going to be tricky for the deepfakers. "Because of the nature of PPG extraction, you cannot back propagate," said Demir.

Teaching a machine-learning algorithm how to account for PPG would also be hard, because the training data isn't widely available. "If you want to approximate it somehow, you need a very large PPG data sets and that doesn't exist yet," said Demir. "There are like 30 people or 40 people datasets, which are not generalisable to the whole population, so you cannot use it in a deep learning setting to approximate PPG signals."

Even if such a large dataset were to exist because, say, a hospital released a raft of data from patients, Demir argues that Intel can upgrade its model to work probabilistically based on correlations in the PPG data – which would mean that the deepfake would need to be even more flawless to pass detection. So, it really does seem conceivable that PPG detection might be the technology that stops deepfakes in their tracks. ■

© Getty

TECH BRIEF

Could Mastodon's elephant trample Twitter?

Mastodon has been the biggest winner from Musk's Twitter takeover.

In the days following Elon Musk's accidental US$44bn purchase of Twitter, it briefly felt like a great migration was underway. Scores of Twitter users announced that because of the uncertainty, or a distaste for the mercurial new proprietor, they were jumping ship, and moving away from the bird app – and will be using the elephant one instead.

At a brief glance, Mastodon appears and functions much like Twitter: users can post short messages – or 'toots' (not 'tweets'), but with a limit of 500 instead of 280 characters. And you can follow people with no obligation for them to reciprocate, just like Twitter.

Under the hood, the system is very different – it is not only open source, but it is 'federated', meaning that there is no singular Mastodon server. Instead, you can sign up to a server – or 'instance' – of your choosing, but still follow anyone else on the broader Mastodon network. And this means that there's much more scope for development and customisation.

This also means that, for example, it's possible to block entire instances, or for the instance administrator to determine who can connect with the community, which makes for a different model of moderation. "Because you can choose who you follow, it operates like a big WhatsApp group for your whole community," said Cook.

In fact, the platform was first launched in 2016, to relatively little fanfare. But the Musk drama has led to a surge of interest, and there are now reportedly over a million users – half of which have been active in the last month. But this has led to growing pains, such as slow servers and unexpectedly large fees for instance hosts. But these are all issues that Cook expects Mastodon to overcome.

"People compare Twitter and Facebook and these sorts of companies' codebases to highly tuned F1 race cars," said Cook. "You can't drive them on a normal road and you're never going to get the same sort of performance out of something like Mastodon."

But in his view, this doesn't doom the platform – in fact, it's more of a feature than a bug. "The net cost of running Mastodon, of the Mastodon network, will be higher than running Twitter or Facebook. But it'll be spread out across many, many people."

So, could it be that in the not-too-distant future, Elon Musk is stuck with a $44bn dead weight? Could Mastodon ever reach a trajectory where it could conceivably replace Twitter? "I think we've already crossed that point for a number of use cases," said Cook. "This idea that I keep coming back to is that we overestimate the impact of events and things in the short term and we underestimate their impact in the long term."

Though Mastodon is still relatively small in absolute terms, one day we could all wake up and realise we're living in a world of toots instead of tweets. "Twitter was the same way," said Cook. "It's this massive cultural thing [but] it took many years to reach that level of cultural saturation."

Others are more sceptical. Marijus Briedus, a cybersecurity expert with NordVPN points out that in the month since Musk acquired Twitter, Mastodon has tumbled from the top 100 most downloaded app to a lowly 600th. "At this stage, any talk of there being any kind of serious rivalry between the two platforms is for the birds," he said. "It would take a Twitter cataclysm for this race to be reignited." ■

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END USER

ChatGPT will probably change journalism forever – but hasn't it already changed?

New AI tech is exciting, flawed, and terrifying, writes Shaun Prescott

Shaun is an Australian editor for *PC Gamer*, *GamesRadar* and *PLAY*, and writes for *APC*, *TechRadar* and more.

The rise of advanced AI technologies such as OpenAI's ChatGPT has brought about numerous benefits to various industries, including the field of journalism. However, as with any new technology, there are also potential dangers that need to be considered. The increasing reliance on ChatGPT for generating news articles and other content is raising concerns about the accuracy and credibility of online journalism. This opinion piece aims to examine the dangers of relying on ChatGPT in online journalism, and to encourage a more critical and cautious approach to the use of AI in journalism.

Oh, and by the way, I didn't write that opening paragraph: ChatGPT did. Did you notice the unusual stiltedness of the prose? Well, if you did, I'll take that as a compliment. AI generated news content has created quite the storm at the beginning of 2023, gathering speed in January after ChatGPT's November 2022 launch. If you ever chatted with Eliza on your Apple IIE back in the day, the format is uncannily the same. Except ChatGPT is by unfathomable degrees smarter, having the entirety of the web's wisdom at its disposal.

So you can't blame some news outlets for experimenting with AI-generated news stories. Or can you? From my point of view – a person who makes a living writing – my instinct is that it's reprehensible. But I can also accept that the world changes and when it does, it doesn't give a damn about me in particular. That consideration aside, these experiments with AI-generated news stories went sour pretty fast, with many found to be rife with errors, and others found to be plagiarising other news outlets.

But that doesn't preclude a future wide scale uptake of AI tech to "generate" written content. It'd be especially handy for boring stuff that is fairly difficult to get wrong, such as simple tutorials. But the only reason ChatGPT is capable of providing this material is because someone else has prepared it somewhere else first; it would not be in the data ChatGPT draws from if it hadn't first originated from the labour of a real human being. So in some respects, ChatGPT is a kind of omnipotent plagiariser, or churner. What say you, ChatGPT?

> ""No, ChatGPT is not plagiarism," the wily robot replied when I asked if it plagiarises. "Plagiarism involves using someone else's work without giving proper credit or permission."

"No, ChatGPT is not plagiarism," the wily robot replied when I asked if it plagiarises. "Plagiarism involves using someone else's work without giving proper credit or permission. ChatGPT, on the other hand, is a language model that generates text based on patterns and relationships it learned from a large corpus of text."

Sure buddy. But actually, it's right. Just as humans rely on their knowledge, which is derived from experience and the reported experiences of others, the AI relies on its own source of so-called knowledge: its data, which – while generated from material created by humankind – is so monumental in its scope that to call it copying would be silly.

Which brings me to my next question: why was one tech news site accused of using "plagiarised" content which was generated by ChatGPT? Well, not because ChatGPT directly cribbed sentences from other sources. What's interesting, is that a lot of the debate over ChatGPT is derived from an anxiety around handing the reins of creative-led pursuits – like writing – to computer systems. But my theory as to why this tech news site's AI-generated material looked plagiarised, is because vast swathes of online content is already utterly beholden to the fancies of algorithms. As a means to game Google's SEO algorithms, most profitable online outlets have adopted an utterly characterless SEO-optimised prose-style that, by all appearances, could have been generated by an AI. GhatGPT is an echo of an echo, in this regard: the computer has had us by the scruff of the neck for years. ■ **Shaun Prescott**

Are writers and teachers about to be replaced by AI?

ChatGPT is changing the conversation on AI writing, but is it a revolution or just chatter?

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Whether it's conservatives stressed out about 'woke' prejudices, or its ability to write high art like King James Bible verses about sandwiches stuck in VCRs, there's no denying the level of competency of the new ChatGPT large language model is different to anything we've seen before. With skill sets including writing and debugging computer code, original jokes (that can actually be funny), songs in musical styles, scientific explanations at different degrees of complexity and the design and creation of games, this publicly available tool is extremely versatile and competent. So much so that tech news outlet *CNET* used the OpenAI chatbot to write more than 75 articles on its *CNET Money* pages between November 2022 when the software was made publicly available and January 2023.

Some journalistic outlets like the *Washington Post* described these AI written articles to be a 'journalistic disaster' citing numerous factual errors and a generally uninteresting and plodding style. *CNET* did claim that these articles were edited and fact checked, so the errors that slipped through are technically the fault of the humans overseeing the story, but if the worst limitation of ChatGPT is that it writes content that's a little dull, then you still have something that's likely to have a large impact on editorial departments around the globe.

ChatGPT's competency is also creating some genuine difficulties in schools with teachers concerned that the software can create A level answers to custom essay prompts in a matter of seconds. And while the New York City education department banned access to ChatGPT servers and web pages, that's hardly going to stop students generating essays remotely. And while there is some software currently capable of estimating ChatGPT authorship ... it's not a black and white answer like you get with plagiarism software, so its usefulness is limited in the education sphere.

In order to quell some of the unrest amongst teachers, OpenAI has promised the addition of a watermark on all AI generated text, but the company has no concrete way of doing that yet, a factor that means savvy students are able to easily generate essays and reports with no way for markers to stop them. There are additional concerns here though with one US teacher wondering how long they will have a job after using ChatGPT to mark and comment on some of his student's writing, telling a *New York Times* reporter "the app had provided more detailed and useful feedback on them than he would have, in a tiny fraction of the time."

While the impacts on the education system are significant, data scientists Nathan E. Sanders and security technologist Bruce Schneier wrote an Op Ed on how Chat GPT will be used to replace troll farms and bot operations that operate to sway diplomatic elections, editorial content and other legislative decisions that affect how our world runs.

While this last point seems like a long bow to draw, we wouldn't have predicted the impact Facebook and Cambridge Analitica's social media profiling data could have had on the 2016 presidential election, so it seems naive to fully dismiss the possibilities of such powerful new technology.

We may not be able to come to a full conclusion of how powerful this tool is just yet, but one thing we do know it's pretty outstanding at is conjuring lyrics about kittens to unwritten death metal songs.

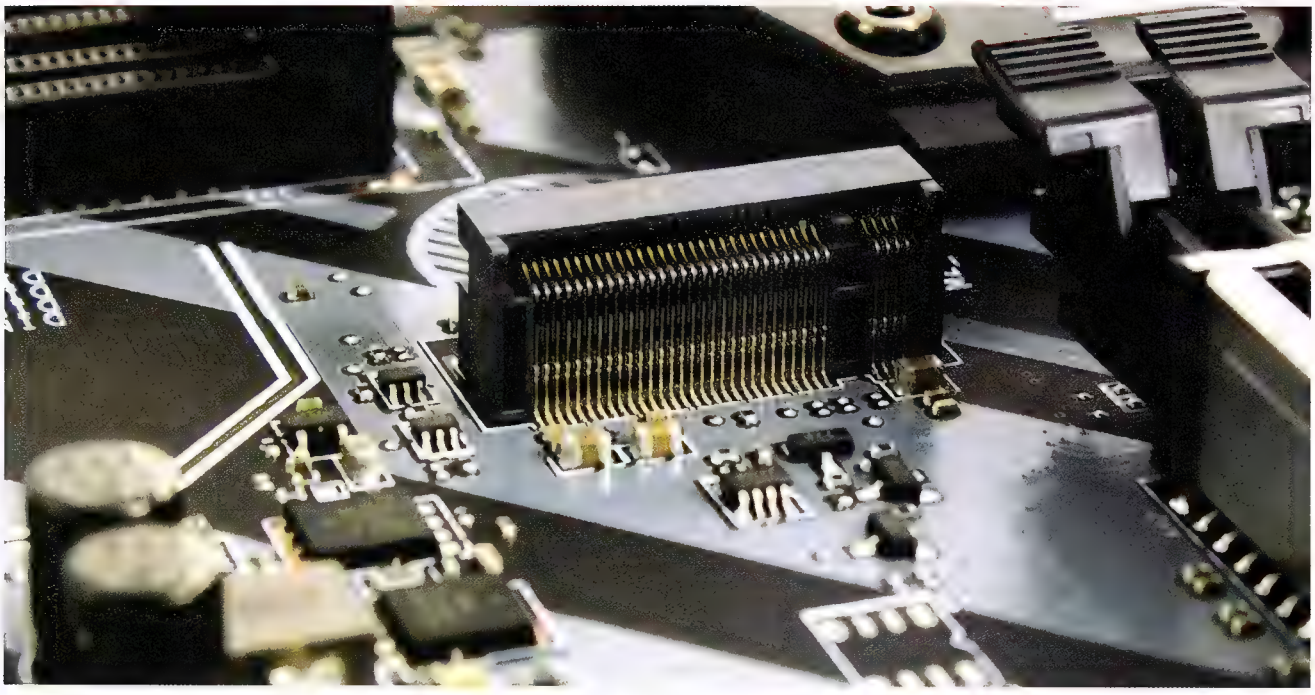
Joel Burgess

Joel is one of the senior journalists on *APC* magazine and apart from being the resident laptop, monitor and fitness tech geek, he's also pretty into surfing his local Sydney beach breaks when he's not in front of a screen.

TWO BITS

Forget about PCIe 5.0 in 2023

If not longer...



Chris has been elbow deep in PCs since before the turn of the millennium, and he wouldn't have it any other way.

One of the brand spanking new features of AMD 600 series and Intel's 700 series chipsets is support for PCI Express 5.0 devices. Simply put, PCIe 5.0 doubles the maximum transfer rate over an equivalent PCIe 4.0 connection. After covering many such boards, I've come to realise just how irrelevant PCIe 5.0 is. Not just right now (with a lack of devices) but for a couple of years at least.

I'm not criticising PCIe 5.0 itself, just its relevance to a desktop PC user. Depending on the specific implementation, AMD's X670E and B650E motherboards include support for both a 16x PCIe 5.0 slot and a PCIe 5.0 supporting M.2 slot. Intel boards have up to 16x lanes, which can be allocated to the PCIe slot, or shared with an M.2 slot. Again, it depends on the specific implementation and chipset.

PCIe 5.0 SSDs are coming soon. But first-generation drives are unlikely to set the world alight. They'll be promoted as being ultra-fast, but this will refer to sequential transfer speeds. If you need to write a single 10GB file in a second instead of 1.5, then that's fine, but it's important to realise that the source or destination speed matters too, so if you're transferring to or from an older drive, that will be your bottleneck.

Your existing PCIe SSDs are good for a few years of competitive performance yet...

It's the responsiveness and latency of an SSD that makes it fast. That's why I liked Intel's Optane drives (RIP). A good PCIe 3.0 or 4.0 drive will remain relevant for many years to come.

PCIe 5.0 SSD are expected to have some serious heat generating components. Just look at some of the heatsinks that motherboard makers are including on the higher end motherboards. They know what to expect.

> "I'm not criticising PCIe 5.0 itself, just its relevance to a desktop PC user."

PCIe 5.0 supporting gaming graphics cards are a long way off. We won't see them until Nvidia launches RTX 50 and AMD launches RX 8000. They're looking like a late 2024 proposition, and only the top end products to start with.

Low end GPus can benefit from PCIe 5.0. We're seeing a trend towards smaller bus interfaces. The Radeon RX 6500 XT has a PCIe 4.0 x4 interface! It's not exactly a powerhouse of a card, but if you run it at PCIe 3.0 x4, it still loses performance. If a 6500 XT loses performance, a future card could suffer even more given generational performance gains. But such cards are probably three years away and worrying about something like that should not interfere with your purchase decision right now.

The takeaway is that a good spec Intel B760 or AMD B650 motherboard loses very little when compared to expensive high-end offerings. A mid-range board with a good VRM, fast networking and connectivity doesn't lose out on a whole lot compared to motherboards at double the price. Do you want USB4? 10G LAN? Those are among the few features that board makers use to justify the high cost of premium tier motherboards.

PCIe 5.0 adds complexity and expense for sure, but at this point in time, unless you need a very fast SSD or need it for professional or enterprise use cases, PCIe 5.0 is all but irrelevant.

But wait, here comes PCIe 6.0 which had its final specification realised over a year ago. Soon we'll have the same discussion again.

■ **Chris Szewczyk**

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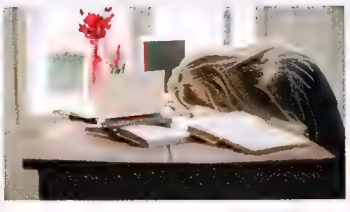

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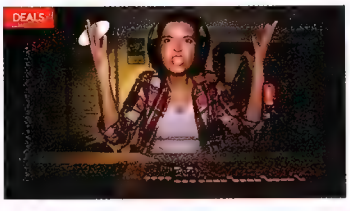

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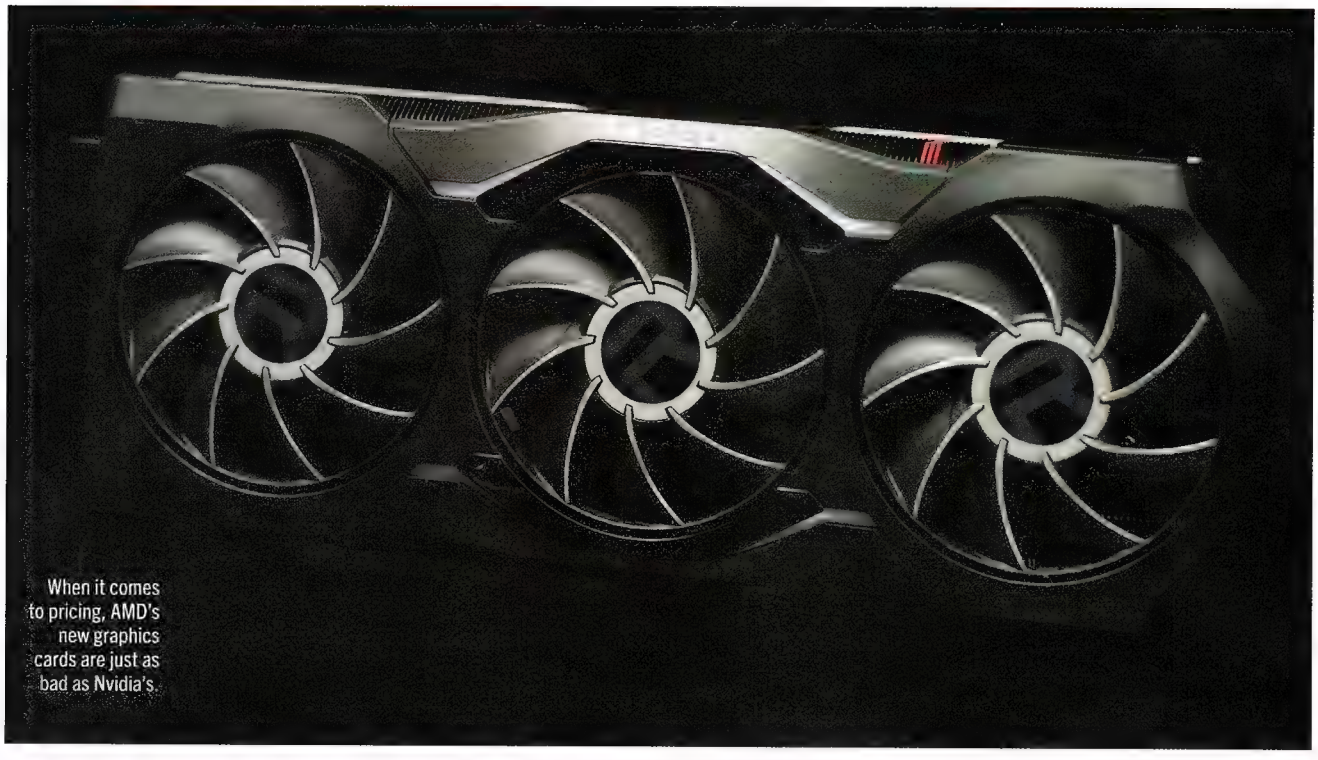
TRADE CHAT

GPU pricing is absurd

This cannot go on. It will not go on



When it comes to pricing, AMD's new graphics cards are just as bad as Nvidia's.

Jeremy Laird
Six raw 4K panels forbreakfast, laced with extract of x86... Jeremy Laird eats and breathes PC technology.

It's not even news to point out that PC graphics card pricing is ridiculous. And yet to merely complain about over-priced graphics boards fails to capture the disconnected, unhinged state of the GPU market. The way AMD and Nvidia priced their new cards makes no sense. It cannot go on.

How we got here is well documented. It was a perfect storm of spiralling crypto-fuelled demand, multiple Covid-induced market shocks and distortions including supply chain disruption, stay-at-home induced consumer behaviour, and a new generation of GPUs that delivered a big boost in performance after several years of relative stagnation. That explains why Nvidia's GeForce RTX 30 Series and AMD's Radeon RX 6000 went through the roof following their launch in late 2020.

It all made sense, even if didn't make paying three to four times the RRP for a graphics card any more fun. But here we are at the end of 2022, crypto has crashed, the influence of the pandemic is shrinking and the latest new generation of GPUs is a mixed bag. Yet both AMD and Nvidia are pricing their new cards as if 2021 is the new normal. Well, it's not. The obvious exception is inflation, currently blighting pretty much every major economy. But inflation nowhere near justifies Nvidia's attempt to price the new RTX 4080 at $2,219, a ludicrous 70 percent price hike over the RTX 3080.

Of course, it took two years for any 3080s to actually hit their $1,139 official RRP. That literally only happened in the last couple of months or so. But, once again, there were clear reasons for that. Moreover, Nvidia has now launched the RTX 4070 Ti with an RRP of $1,479. And that is for a third- or fourth-tier GPU.

AMD's new cards are no better. The Radeon RX 7900 XT and 7900 XTX at $1,619 and $1,789 would have been priced even higher had they offered more competitive performance. Along with Nvidia's new-gen cards so far, they simply beg the question of what the mainstream PC gamer is supposed to buy? AMD and Nvidia seem to have forgotten that PC gaming is a mass market pursuit.

Graphics cards aren't, say, boutique supercars that can be made in their handfuls and bought by a few ultra-wealthy clients. PC gaming as an industry depends on accessibility. Because millions of PC gamers can't afford $2,200+ for a new graphics card, let alone $1,600 or more. That's never been the case in the past and it hasn't become the case now. Only the laziest observer would conclude that was even the case at the height of the crypto-Covid GPU craze, ignoring the highly unusual combination of an acute shortage of GPUs combined with a higher-than-usual demand.

Put simply, there is no way that PC gaming as a mass pursuit can thrive in an era of $1,500 mid-market GPUs. Prices are, therefore, going to come down. The only question is exactly how long it takes and how much damage is done to PC gaming in the interim.

It's an incredibly short-sighted way to go about things from Nvidia and AMD. They're not just ripping off gamers, they're hurting their own businesses. The longer they stick at this nonsense, the smaller the remaining market of PC gamers is going to be when they come back to their senses.

Jeremy Laird ■

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The *worst ideas* for the future

Living amid future technology can be inspiring and exciting – and also depressing. Nicole Kobie examines seven of the worst ideas yet.

Logging on to a work meeting in the metaverse with your legless avatar. Emptying the vacuum bag of your humanoid robot butler every day after it's finished the floors. Having to call the police to tell them you're on a rollercoaster, not in a fender bender. And paying for it using a cryptocurrency with such fluctuating value that you're never sure how much it's worth. Welcome to our dull, uninspired version of the future.

There are exciting visions of the future in the making: driverless cars could rework cities, augmented reality could upend everything from entertainment to education, and robots could release us from physical labour. But right now, we're building a suburban dystopia.

Why are we so bad at imagining our futures? "We spend surprisingly little time thinking about the future," said futurist Tom Cheesewright. "At least, in a structured way. I try to get my clients to commit one percent of their time – one day every six months – to thinking about the future. But even that's a struggle. We just have a lot going on."

"Part of it's actually evolutionary," explained futurist William Higham. "Our brains evolved to focus on that which is most immediately essential to our survival. We evolved to pay attention to immediate threats – and things we'd faced before. So we learned to filter out thoughts of anything else: for instance, longer term or less likely events."

If you don't buy that we're still in caveman mode, worried about tigers lurking behind that boulder, Higham notes that there's a range of cognitive biases that impact how we think about the future. First, there's hyperbolic discounting, in which we see our future selves with less interest and emotion as our current selves, as though it's another person. "This is why we choose short-term pleasure over long-term rewards: the former feels like we're helping 'me', the latter like we're helping 'someone else'," he explained.

Then there's the sunk cost fallacy, which assumes something will be good because we've spent a lot making it. "When thinking about how the future will look, we don't like to think there will be bad news," Higham added. "We also typically focus more on what technology and tech products there will be and less on social interactions and lifestyle, even though the latter often has more impact."

Cheesewright argues that we outsource a lot of our thinking about the future to science fiction. "Science fiction needs narrative devices that move the story along, more than it necessarily needs plausible or even probable advances," he said. "That said, sci-fi has got an awful lot right, and it's hard to disentangle it from science fact."

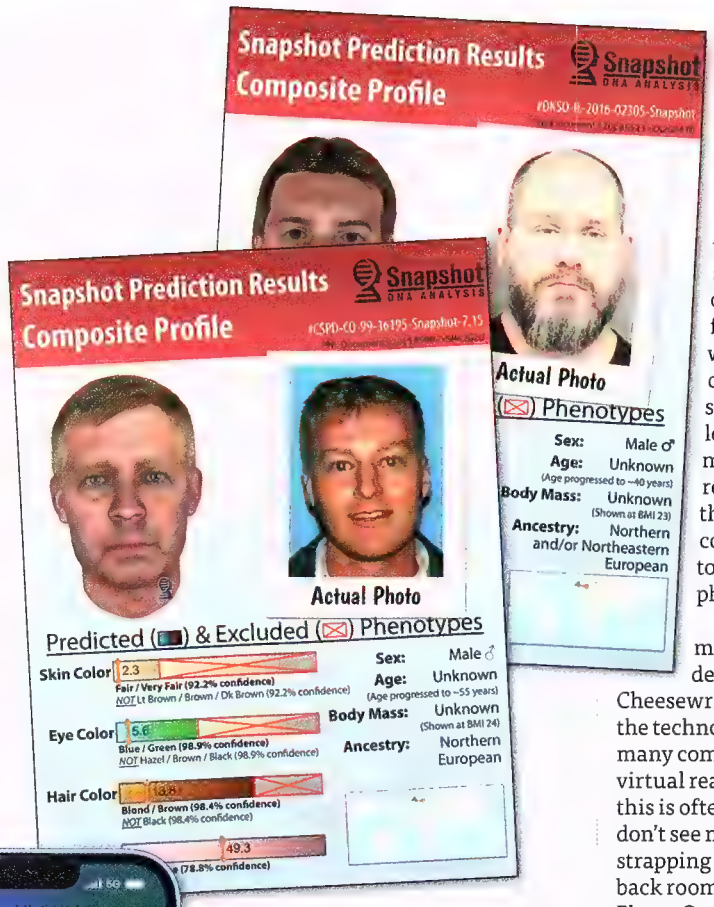
Here are seven ideas that shouldn't be allowed to join us in the future as facts – not without a bit more thought and consideration, at least.

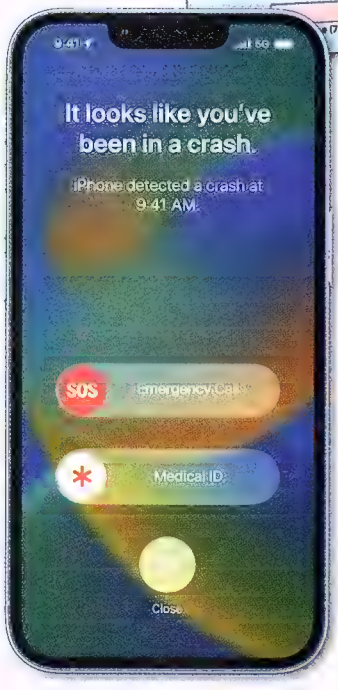
1 Automated emergencies

The Apple iPhone 14 has a neat trick: it can call the emergency services if it thinks you've crashed your car, making use of sensors such as the accelerometer to detect an impact. If you've enabled the feature, it will then pop a message up on the display: "It looks like you've been in a crash. iPhone will trigger Emergency SOS if you don't respond." Fail to swipe away the notification and the phone will call emergency services with a prerecorded message.

On a technical note, it's certainly impressive. And the motivation is sound: it could get help to unconscious victims more quickly. But Apple's engineers didn't think through all the different scenarios in which a person could move quickly, come to sudden stops, and not have their arms free to swipe away a notification: notably, on rollercoasters.

That's what happened to one





woman in the US, who realised her iPhone 14 Pro had dialled 911 (as the number is there) while she was whipped about the Mystic Timbers rollercoaster at Kings Island park in Ohio. It wasn't a one-off: in the month after the phone was released, local dispatchers had six automated calls from Kings Island thrill seekers, wasting their time investigating each.

"We probably need a lot more response capacity for this, since it will likely pick up a lot of false positives," said Cheesewright – and he has a future-tech solution, too. "It would be interesting if you could send out a fast-moving drone to a scene in a few seconds to scope it out before sending the full response team." One for the authorities in Ohio to perhaps consider.

2 Wanted ads from DNA

Canadian police in the city of Edmonton had no witnesses, CCTV or other identifying evidence for a sexual assault from 2019, so they took a leap into the future: they used DNA phenotyping to create a 3D image of the perpetrator. The police turned to an American company called Parabon NanoLabs, which analyses DNA samples and extrapolates that data into physically identifiable characteristics, such as likely hair and skin colour, face shape, height, and so on. From that, a composite "snapshot" is made of the suspect, and the police released that guess of an image. And from the images released by the company, the prediction image naturally varies wildly from reality, though Parabon NanoLabs does have a list of cases that it's helped to solve.

At the time, the police force said: "It is important to note that DNA phenotyping composites are scientific approximations of appearance based on DNA, and are not likely to be exact replicas of appearance." After the apparently unexpected wave of criticism, in particular around the potential for the wrong person to be identified as the culprit, especially given racial biases, the police quickly pulled the image with a promise to review their internal procedures.

Cheesewright was surprised by the police releasing the image in the first place. "As a way to inform police or validate witness reports? Maybe," he said. "Should these raw profiles be released to the public? I don't think so. But that's just my opinion."

Above: Police in Canada used DNA phenotyping to create an image of a suspect.
Left: It looks like you've been in a crash – or on a rollercoaster.

3 Metaverse

Meta CEO Mark Zuckerberg would disagree, but a virtual meeting room where work colleagues' avatars can gather to discuss marketing proposals or the quarterly results or plans for the office Christmas party is one of the dullest versions of our digital futures.

While overengineered, all the tech skills behind the metaverse fail to make up for the failings of videoconferencing – it still doesn't let us pick up on body language cues, for example, and no wonder given Meta's developers are still struggling to give avatars legs. While virtual meetings could help reduce the exhaustion that comes with being constantly on camera, so too does picking up the phone instead.

"The problem with the metaverse is one of definition," said Cheesewright. "Because it is what the technology supports today, many companies are pushing a virtual reality meeting space. But this is often a clunky experience. I don't see millions of people strapping on rubber suits in their back rooms in the style of Ready Player One."

But he does think more melding of digital and physical spaces using augmented reality could be more intriguing, once hardware and design catch up. "Not pop-up windows in front of your face but something more natural: information carried through colour and sound, virtual creatures and people, and digitally enriched environments," he predicted. "I believe that could and will take off. But there's a lot of work to do before we can get there, both on hardware and more importantly on design."

Below: Has the metaverse got legs? Its avatars haven't.

4 Hyperloop

There's a rumour kicking around the internet that Elon Musk doesn't actually want to build a hyperloop; that when he released his white paper outlining the idea, he really just wanted to disrupt plans to build actual high-speed trains linking urban centres in California so he could sell more Teslas. Whether or not that's true, hyperloop doesn't exist and quite likely never will.

Of all the challenges facing high-speed rail networks, friction isn't the one that's holding back public infrastructure projects, but that's the only solution hyperloop, in its vacuum tubes, offers to solve. Rail networks are expensive and difficult to build and train services are more expensive than they need to be to persuade people out of

cars. The speed of the trains themselves isn't the problem, not least given the pace of Pendolinos in Italy and Shinkansen in Japan.

A hyperloop, if ever built, would in theory be faster than such superfast trains, but it would be more expensive to build, requiring sealed tunnels that limit the number of services that can run at any given time. Trains need to be cheaper and easier to build, not slightly faster but harder and more expensive.

"I genuinely admire Elon Musk's desire to create physical products and infrastructure," said Higham. "But this one just feels like a 'back of a napkin' idea that just doesn't work in practice. With so much time and money being spent on it, I believe there's still yet to be even a single mile of fully operational track."

5 Cyborgs

Augmented humans already exist, of course. And the idea of putting a chip into a brain is usually focused on battling diseases such as locked-in syndrome. But the idea that we'll extend our lifespans by slipping our brains into robot bodies is fraught, as is the idea that we can ram a chip into our heads to be smarter.

It's not the technology that's necessarily the problem. We're just rather complicated sacks of meat. "You can't just transplant a brain into a robot body and expect the personality to carry across: our bodies define us as much as our minds," said Cheesewright.

And what about the other way around? Can we cram tech into our bodies to improve our lot in life? "Lots of people ask me: 'when will my mobile phone just be a chip in my head?'," said Cheesewright. "And I point out your mobile phone is usually updated every two years. Do you want invasive cranial surgery every two years? That's before you consider the possibility of bad apps, malware and hacking."

There's potential to do real good by adding technology to our bodies, as soon as we stop trying to make it a product – or a weapon. The US Army slapped AR headsets onto soldiers, and while Cheesewright fully expects this to be the future of warfare, he isn't surprised by the result: the system didn't help the mock battle so much as lead to a lot of vomit.

"It's tough approximating reality in a way that doesn't screw with your synapses," he said. "But the potential tactical advantages of target tracking, enhanced night vision, even the ability to see through walls? Incalculable."

6 Robot butlers

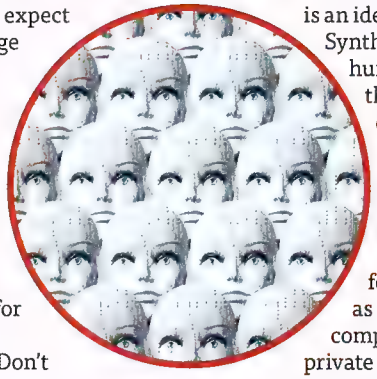
Keeping a home clean and maintained isn't easy amidst busy work and family demands. So it's no surprise that the idea of a robot butler lingers – it could pack lunches, walk the dog and vacuum the floors. Why do such work when you can hand it to a machine that never feels tired and doesn't expect to be paid the minimum wage with sick pay?

Of course, we have home robots. Perhaps the most successful are Roomba and their rivals: round vacuums that automatically clean floors without the need for human intervention. Well, first you need to find a spot for the larger-than-you'd-think robot to park and recharge. Don't forget to empty it, too.

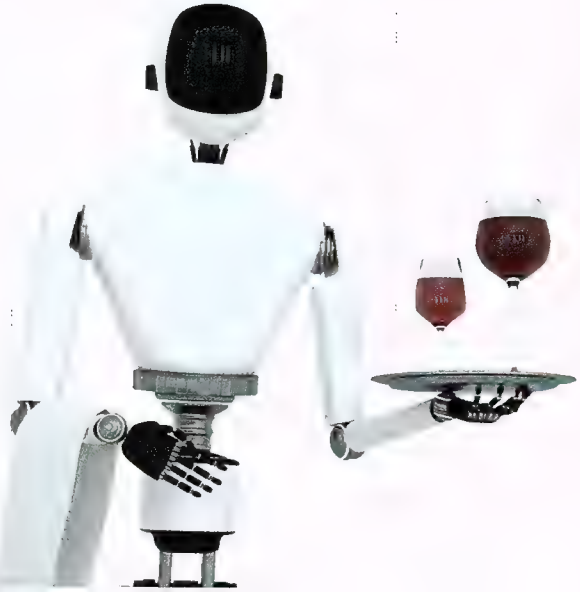
Humanoid robots are massive in order to contain the joints and support necessary to avoid falling over. Forgetting even the technology leap forward that would be required in AI to make a generalist robot that can complete any task you'd like, where would it live in your home? It's hard enough finding a spot to tuck away the vacuum. Instead, if and when such technology is perfected, it should be put to use in hospitals supporting staff with in-depth cleaning and lifting heavy objects, including sick patients.

"Making something that looks and moves like a human is expensive, and frequently a bit creepy," said Cheesewright. "A human body is not the ideal form factor for a lot of jobs. The advantage is its flexibility. But for many things, a different shape makes more sense – such as a robot vacuum cleaner, though one that can do stairs would be amazing."

Left: Will a hyperloop ever be built? Our futurists have their doubts.



Above: A human brain in a robot body won't help us to live longer.
Left: The drinks are on us: humanoid robots could help out in hospitals .



7 AI for government

Artificial intelligence is being used to generate art, spot disease in medical images and decide jail sentences; should we let it rule us too? Here in Australia it may seem as though it couldn't possibly do any worse than our human MPs, but this is an idea from Denmark. The Synthetic Party seeks to get its human members elected, but they'll follow a platform developed by AI based on decades of fringe party policies.

That includes electoral reform, universal basic income and a rehabilitation-focused justice system, as well as a publicly owned internet company that can compete with private ones to combat online monopolies. If some of those ideas seem sound, it's because – like most generative AI – they're curated by humans. That's the safest and best way to use this type of AI: to spark ideas that are then further developed by knowledgeable people.

In that sense, the Synthetic Party isn't necessarily a bad idea. But letting AI make decisions without a human in the loop – let alone all the decisions made by government – isn't a wise move, as AI too easily embeds our prejudices and previous mistakes. "Should we let AIs make all the calls? No. They don't yet have the sophistication and might never have the compassion – though nor do some politicians, clearly," said Cheesewright. "Should we use machine learning and predictive analytics to model the future and provide better information to policy makers? Absolutely." That said, it is really tempting to replace them all with robots. ■

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FUTURE

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The A-List

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PREMIUM LAPTOPS

APPLE MACBOOK PRO 14IN

STUNNING CREATIVE POWER

Alongside its 16-inch sibling, this is simply the world's best laptop for demanding users. The amount of power on tap via the M1 Pro or M1 Max processor is staggering, and it's backed up by a terrific screen and stunning battery life. With all the ports you could ask for, the only negatives are its relative bulk (especially compared to the Air) and high price.

From $2,999, apple.com/au

ALTERNATIVES

DELL XPS 15 (2022)

Surely the best Windows all-rounder money can buy, with a slim design, gaming potential and plenty of power courtesy of Intel's 12th gen Core processors.

From $2,924, dell.com

APPLE MACBOOK AIR

The MacBook Air M2 looks like a standout to us. A powerful and quiet ultraportable with an unbeatable battery life and a great pro display.

From $1,899, apple.com/au

MICROSOFT SURFACE PRO 9

APC rates the Intel model highly, the SQ3 model less so. With Intel, you get a solid upgrade to the world's leading detachable tablet laptop.

$2,549, microsoft.com

BUSINESS LAPTOPS

DELL XPS 13 PLUS

DELL'S NEW FLAGSHIP IS A STUNNER.

The updated XPS's headline features include a notably more powerful Intel 12th generation CPU, an optional OLED touchscreen panel, an integrated glass touchpad palmrest and a neat capacitive touch bar. A powerful luxury laptop that's up there with the very best.

$2,339, dell.com/en-au

ALTERNATIVES

LENOVO THINKPAD Z13 GEN 1

The perfect laptop for executives, with amazing battery life backed up by strong performance. A great debut for the Ryzen Pro 6850U.

$2,929, lenovo.com/au

LENOVO THINKPAD X1 CARBON GEN 9

A business laptop with heaps of luxury, especially if you choose the top-end model with a 3,840 x 2,400 screen.

$2,959, lenovo.com/au

DYNABOOK PORTEGE X30W-J

This 2-in-1 convertible is ludicrously light and slim, and offers a quiet keyboard, great performance, ports a-plenty, and a nice touchscreen.

$2,083, anz.dynabook.com

GAMING LAPTOPS

RAZER BLADE 15 (2022)

A SUPERBLY ENGINEERED GAMING POWERHOUSE

Right now there's just not another better gaming unit around. It's miraculously thin considering the beefy components inside, thermals are very well managed and the Razer Blade 15 manages to extract very good performance from its GPU without undue throttling. There are many variants and options, and they're an outstanding buy if you find one on sale. **~$4,499, razer.com/au-en**

ALTERNATIVES

LENOVO LEGION 5I PRO (16IN)

A great-value gaming laptop that's extracts the most from its powerful components. We really love the keyboard, too.

From $2,649, lenovo.com/au

AORUS 17

If you're after a device to seriously game on, and you don't care about the bells and whistles then this is a great option that cuts costs in all the right places.

$3,699, gigabyte.com

ASUS ROG ZEPHYRUS G14 (2022)

A powerful gaming ultraportable that lights up for both work and play. The AMD CPU and GPU balance well.

$3,99, asus.com/au

EVERYDAY LAPTOPS

MICROSOFT SURFACE LAPTOP GO 2

FEELS LIKE A PREMIUM ULTRABOOK, BUT COSTS HALF AS MUCH.

A solid update to an amazingly good value mid range ultrabook. It runs cool and quiet, and has up to 30 percent better battery performance than its predeccessor, all in a beautifully designed form with a superb keyboard and trackpad.

From $1,099, microsoft.com/en-au

ALTERNATIVES

LENOVO YOGA SLIM 7 PRO

A powerful, well designed ultrabook with an awesome OLED screen for a good price. The original 2-in-1 bends into a new clamshell shape.

$1,699, lenovo.com

HP ENVY 13 (2020)

It may not be the world's most exciting laptop, but the Envy 13 is a compact and forward-looking machine that's ideally suited to these homeworking times.

$1,699, store.hp.com

HP PAVILION 14

This slim 1.4kg laptop is a superb choice for anyone on a tighter budget. it struck an excellent balance between speed and battery life – around ten hours.

From $999, store.hp.com

CHROMEBOOKS

ASUS CHROMEBOOK FLIP CX5

The best big-screen Chromebook we've tried, with a bright 15.6in Full HD display with decent black levels and surprisingly rich colours. And it's a good specification for the price, with a Core i3 processor, 8GB of RAM and a 128GB SSD in tow.

$1,213, asus.com/au

LENOVO FLEX 3 CHROMEBOOK

This isn't the most powerful Chromebook, but students need reliability more than power – especially if they're only really using it for homework, note-taking, and perhaps the occasional bit of Netflix.

$484, lenovo.com/au

LENOVO IDEAPAD DUET

The Chromebook answer to Microsoft's Surface tablets, this is a seriously versatile device – albeit not the speediest (although we never found it to be painfully slow while carrying out everyday tasks). For this price, and with a 16hrs 14mins battery life, the Duet is a great choice.

$899, lenovo.com/au

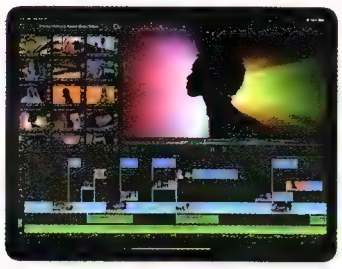
TABLETS

APPLE IPAD PRO 12.9IN (2021)

M1 POWER IN YOUR PALM FROM $1,199

Blurring the boundaries between laptop and tablet like never before, the M1-powered iPad Pro 12.9-inch is every bit as fast as we expected – and the "Liquid Retina XDR" display is simply phenomenal.

From $1,649, apple.com/au



APPLE IPAD (2021)

Apple performs its usual trick of upgrading just enough to keep the iPad affordable and up to date, without treading on the toes of its more luxurious stablemates. The big bezels remain, but a faster processor, more storage and improved camera all add to its appeal.

From $499, apple.com/au

SAMSUNG GALAXY S8 ULTRA

The Samsung Galaxy Tab S8 Ultra is an enormously impressive tablet. It makes a fantastic first impression with its gorgeous screen and thin body, and is great for multitasking. If you want the best Android tablet going, there's no question at all that this is it.

$1,499, samsung.com

EVERYDAY MONITORS

PHILIPS BRILLIANCE 346P1C

34-INCH CURVED DOCKING,

No-one can match Philips for its mix of quality, features and value, especially when it comes to curved MVA monitors such as this. It's great for casual gamers and busy workers alike, with USB-C docking and superb colours.

$849, philips.com.au

EIZO FLEXSCAN EV2480

Businesses in particular will love this easy-to-roll-out 24-inch monitor, with its exceptional five-year warranty, USB-C port for easy docking, excellent viewing angles and delicious whites. And it has the best OSD around.

$699, eizoglobal.com

DAHUA DHI-LM28-F420

This affordable 4K monitor might not offer much in the way of menu options or high-end gaming perks, but it offers impressive resolution and colour for ally pay.

$269, dahuaaustralia.com.au

PROFESSIONAL MONITORS

EIZO COLOREDGE CG319X

CREATIVE MASTERCLASS, $7,119

As the price indicates, this monitor is for heavyweight creatives who demand the best in every discipline: HDR video editing, print layouts, professional photography and more besides. With superb coverage and accuracy across all spaces, plus a built-in calibrator, it justifies the investment.

$7,119, eizoglobal.com

BENQ PD2725U

By no means a cheap 4K 27-inch monitor – unless you compare it to the Eizos – but it marries all-round quality with ease of use thanks to a puck that allows you to quickly move between settings. You can even daisy chain a second Thunderbolt 3 monitor for a monster setup.

$1,799, benq.com

EIZO COLOREDGE CG279X

Designers who need to work across different disciplines will love how easy it is to switch between the Adobe RGB, DCI-P3 and sRGB colour spaces using the Eizo's fantastic OSD. It's certainly not cheap for a 27-inch 1440p monitor, but it's packed with quality.

$3,095, eizoglobal.com

HOME OFFICE PRINTERS

EPSON ECOTANK ET-1810

BACK TO BASICS

There's nothing flashy about this bottle- fed inkjet: it's there to churn out pages at a decent rate (8.8ppm for black text) for a low price. It comes with enough ink for 4,500 black pages and 7,500 in colour, but refills are cheap. Just don't expect features like duplex printing.

$299, epson.com.au

CANON PIXMA PRO-200

Yes, it's big and it's expensive – and you don't even get a scanner – but the Pixma Pro-200 means that you can print A3 photos with glorious colour accuracy and detail. If you're after an office workhorse, look elsewhere, but it can't be beaten on photo quality.

$809, canon.com

BROTHER MFC-J4540DWXL

Home workers will love this inkjet all-in-one. It combines an incredible range of features with all the connectivity you need and extreme ease of use. Output quality is fine, it offers the best cloud support around and the high-capacity ink pack could keep you going for years.

$420, brother.com

WIRELESS ROUTERS

SYNOLOGY WRX560
THE PERFECT ROUTER
Its quad-band Wi-Fi smashed-through our performance tests managing 791.5Mbps up close, 375Mbps two rooms away and an amazing 216.7Mbps down the garden..
$599, synology.com/au

ASUS RT-AX82U
The impressive RT-AX82U punches well above its price when it comes to raw Wi-Fi 6 performance and includes a fistful of useful features – such as an ultrafast 20Gbits/sec USB connector, outbound VPN support, site-blocking and a host of parental controls.
$320, asus.com/au

SYNOLOGY RT6600AX
Fast, well-featured and secure, the Synology RT6600ax is as perfect for professionals and prosumers as much as it is for SMBs and smart homes, and the app and interface are a delight to use for both experts and plug and play users alike.
$599, synology.com/au

MESH WI-FI

TP-LINK DECO XE75 AXE5400
SUPERB WI-FI 6 MESH
Offers the simplicity, speed and range most people want from a mesh system. While it's expensive, nothing else offers the plug-and-play simplicity, speed and range afforded by the Deco XE75.
$999, tp-ink.com

TP-LINK DECO X20
The price below isn't a typo: the Deco X20 makes it possible to upgrade your home network to Wi-Fi 6 – as well as manage its security – for the price of some standalone routers. The included HomeCare functions are also a great bonus for households where lots of devices are fighting over the bandwidth. **$199, tp-link.com**

ASUS ZENWIFI AX
The interface and design certainly aren't the prettiest (the nodes look like mini space heaters, while the charcoal version is straight out of the 1980s), but if you're after strong performance, great features and plenty of expansion potential, the ZenWiFi AX is a compelling prospect.
$949, asus.com/au

NAS SERVERS

QNAP TS-130
SIMPLE HOME NAS
An above average CPU and RAM combo, solid features and affordable price make the QNAP TS-130 worth considering. Alternatively there's the two bay TS230 which features the same CPU, with 2GB of RAM, dual drive bays, and an extra USB port on the front for a modest $50 price increase.
$250, qnap.com

ASUSTOR NIMBUSTOR AS5304T
This is a hugely powerful four-bay NAS that will be overkill for most people – not just due to its speed but also its slightly intimidating user interface – but techies and gamers should investigate the Nimbustor AS5304T for both its speed and flexibility.
$799, asustor.com

SYNOLOGY DISKSTATION DS1522+
At $1,199 it's not cheap but factoring in the software means it's great value. Though some internal silicon may lack headroom, this is still a well-featured, expandable NAS with fantastic software. The best part is the DSM software.
$1,199, synology.com

SECURITY SOFTWARE

F-SECURE SAFE
F-Secure concentrates on the basics: faultless protection with minimal impact on your system's performance – for a low price.
1-3 PCs, 1yr, $99.99, f-secure.com

VPNs

NORDVPN
NordVPN provides consistent and fast speeds, serious security, great support for video-streaming services and some cost-effective subscription rates.
$59 per year, nordvpn.com

PASSWORD MANAGERS

BITWARDEN
Bitwarden has a huge advantage: it's free. It isn't as slick as some paid-for rivals, but it can sync passwords across all devices for no extra charge. **Free, bitwarden.com**

ALTERNATIVES

NORTON 360
Consistently on the podium in our group tests, and loaded with an abundance of genuinely useful features, including a VPN and generous cloud backup.
1 PC, 1yr, $79.99, nortonlifelockpartner.com

AVAST FREE ANTIVIRUS
For the second year running, Avast is our top pick for free antivirus software – it's simply lighter on its feet than Microsoft Windows Security, whilst offering fewer false positives.
Free, avast.com

ALTERNATIVES

PROTONVPN
ProtonVPN provided one of the best free offerings of all the VPNs in our group test, including unlimited data, but upgrade to benefit from even faster speeds and many more options.
Free, protonvpn.com

SURFSHARK
A strong rival to NordVPN, especially if you're willing to commit to its two-year contract. It's fast, cheap and a fine choice for people who like to switch to US streaming services.
$66.34 for one year, surfshark.com

ALTERNATIVES

DASHLANE
A manager that's ideal for beginners, and it even builds in an unlimited (if basic) VPN service. Note you may prefer to buy the Family plan ($60 per year) as this extends the service to six people.
$55.99 per year (Premium), dashlane.com

1PASSWORD
1Password is targeted at technically minded users who are looking for the last word in security. It even offers a Travel Mode that may ease your mind if surrendering your phone to customs officials.
$54.99 per year (individual), 1password.com

The best USB Wi-Fi Adapters

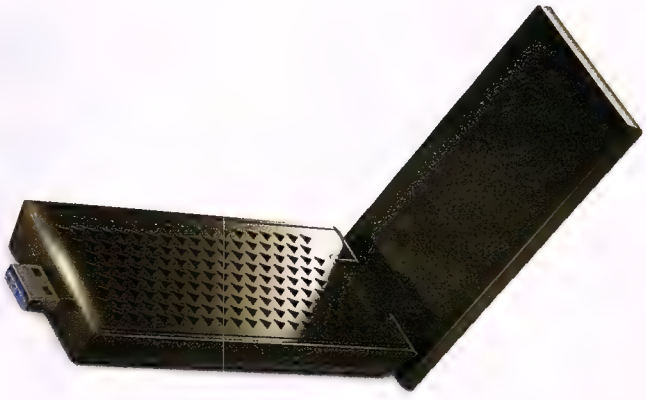
While it's true that most laptops and desktops these days come with Wi-Fi on board, there are still plenty of budget motherboards that don't. There are also many instances where your home network becomes more technologically advanced than that available from your devices, meaning you can't take advantage of the increased speed and range. Or some of you might have finally set up that home office in a shed at the end of the garden. Whatever the reason, we've listed five of the best ways to add Wi-Fi to your setup through the good old medium of USB.

1

TRENDNET AC1900

www.trendnet.com $70

One glance is enough to confirm this is the professional choice for USB Wi-Fi adaptors – just look at this thing! It's clearly not meant for portability, instead offering four positionable antennae each with a strength of 5dBi each. This means it's best suited for situations where the Wi-Fi signal is weak – surprisingly it's not the fastest receiver we've used and doesn't support MU-MIMO either.



2

NETGEAR NIGHTHAWK AC1900

www.netgear.com $129

This is the wireless dongle for gamers. It comes with a magnetic cradle so you can stick it on top of your gaming desktop for (hopefully) a better signal. As the name suggests, this is a blazing-fast AC1900 connection and performed brilliantly in terms of speed and range in our tests. We wouldn't use it in a laptop, however, as we'd frankly be scared of snapping it off given its relatively large size.

3

ASUS USB-AC68

www.asus.com $148

As you can tell from those two cute little antennae, this is where our wireless dongles start to get serious. This stick supports USB 3.0 for faster transfers, the AC1900 standard for even more bandwidth, and all the Beamforming and MU-MIMO features you'd expect at this price. However, somehow, it's not the fastest on either 5GHz or 2.4GHz channels, hence it being in our number three position.

4

EDIMAX EW-7833UAC

www.edimax.com $49

A step up from the Linksys in terms of physical size and speed is the EW-7833UAC. It supports the newer AC1750 standard, which will boost speeds across both 5GHz and 2.4GHz bands. Besides, if it's pure speed you're after, then Edimax's stick smokes the competition – the only downside is that it doesn't have the best long-range wireless performance, so isn't the one to buy if you're after a Wi-Fi connection for the end of the garden.

5

LINKSYS WUSB6300

www.linksys.com $44

This is the adapter to go for if size is key, as this thing is absolutely tiny – even Linksys itself calls it 'micro'. It's nowhere near the fastest at AC1200 speeds, but 860Mbps via a 5GHz channel should be speedy enough for most users. MU-MIMO and Beamforming support also means that range won't be an issue and you can stretch even further away from your router with this than with many other more expensive adaptors.

TECHNOTES

Gadgets

Tricky devices.

❶ SENNHEISER CONVERSATION CLEAR PLUS

The non-hearing-aid aids for your hearing.

$1,399.95 | en-au.sennheiser.com

If you're reading this because the volume on your TV doesn't go high enough for you to hear movies properly anymore then it's probably time to go out and get a hearing aid. One in five people with hearing loss never actually get one, even though services and products are often entirely covered by the Hearing Services Program for a large portion of the population. If you're hearing is great, but you just wish you could turn up the volume on the world a little when you want, then the Sennheiser Conversation Clear Plus is the $1,400 pair of voice enhancing headphones for you.

❷ LEKKER JORDAAN GT EBIKE

An e-bike built for Aussie roads.

$3,898 | lekkerbikes.com.au

The Jordan GT eBike is an urban-optimised mode of transport that has ample space for you to carry your luggage across the city without the need to break a sweat. With a comfortable easyrider style, big leather seats and an 80 Nm motor that'll help you get around at up to 25 km/h, this might just be one of the easiest, most comfortable ways to get around. There's front and rear luggage racks, complete with accompanying straps and inbuilt headlight and taillights to ensure you can carry whatever you need wherever you want safely and easily.

❸ GE PROFILE SMART MIXER WITH AUTO SENSE

A smarter way to bake.

US$999 | geappliances.com

There have been way more failures than successes in smart kitchen accessories, but the Smart Mixer from Haier's GE Appliances looks genuinely interesting for anyone that likes baking. The device features a built in scale that makes it quicker to get the measurements exactly right. It's also got an 'Auto Sense' motor that allows it to respond to changes in viscosity to not over-mix and you can even control it with your voice by connecting it to your smart speakers. This last point might seem trivial, but it's actually pretty common for your hands to be covered in messy dough right when you need to turn the mixer on, off, up or down.

4

ALIENWARE CONCEPT NYX

Reduce sign-in effort to nix

$TBC | dell.com

Dell is thinking about how to make account management easier for the consoles in share houses, dorm rooms and other dwellings with multiple gamers by adding a fingerprint reader to the controller. This automated sign in process would allow users to pick up where they left off by just picking up the controller and dramatically reduces the hassle of swapping accounts. The concept Nix also wants to add haptics and variable resistance to the triggers and joysticks so they feel different when controlling heavy vehicles or wielding cumbersome weapons. It's not quite in production, so you'll have to wait for Alienware to actually release this one, but hopefully it actually will.

5

VIVE XR ELITE

Is VR finally where you want it?

US$1,099 | vive.com

It might've taken many years to realise, but the Vive XR Elite is pretty close to what we envisioned XR to be. It's still not quite as thin and light as a pair of sunnies, but according to early reviews it's impressively light for a VR headset and the almost 4K resolution, 90Hz refresh rate and ultra fast camera passthrough make this headset awesome for both VR and augmented experiences. The device offers binocular-like focus and eye width adjustments so you can wear it without glasses, and you can turn it into a PC VR headset using the included cable or take the rear battery off for ultra portability.

6

CORSAIR XENON FLEX

Corsair wants its new gaming monitor to get bent.

$1,999 | corsair.com

The Xenon Flex is a new Ultra-wide, 240Hz, OLED monitor from Corsair that would sell on the aforementioned specs alone, but it's got a trick that makes it rather unique: you can bend it into a curved Ultra-wide. For us, the bendability is a bit of a novelty, since you can do just about everything with a curved display, but there are some design applications where you might want a flat screen. The 800R curve isn't quite as pronounced as we'd like either, but it's unbelievable for something that you can also watch flat. There's plenty of other gaming tech too, for those that can justify the price.

2-IN-1 LAPTOP

Dell XPS 13 2-in-1

Is Dell's new detachable tablet good enough to be a real Surface Pro competitor?

■ $2,698.30 | dell.com/en-au

The 2-in-1 market certainly isn't what it used to be, and with so many players dropping out of the race Microsoft has been left with little competition to its Surface Pro range, but Dell might be about to change that with a new XPS 13 2-in-1 detachable tablet and cover keyboard. The new device could be just good enough to sway users from the Surface Pro 9, with Dell promising a 5G variant to be released following the initial Wi-Fi 6E version release – though local Dell people tell us there are sadly no plans to have that model sold here.

Dell sent us a WiFi XPS 13 2-in-1 with an Intel Core i7-1250U CPU, 16GB of RAM and a 512GB PCIe SSD that retails for $2,698.30. This price point is virtually identical to the Surface Pro 9 offering, but if you're looking at an entry level i5 model, you can actually get comparable specs on Microsoft's offering for $580 less. This isn't too surprising considering how long the Surface Pro range has been around, but it does make it harder to justify this newer and riskier offering.

Fortunately Dell has a lot of experience to draw on, so the device held up perfectly in general work benchmarks by keeping up with anything an Intel Core i7-1265U CPU on a Surface Pro 9 can muster. This is more than enough for intense web browsing, heavy document processing and lighter photo or video editing. There's not really a gap between tablet and Ultrabook performance these days, and while the Surface Pro range has always sold the keyboard separately, Dell bundles the Folio Backlit Keyboard and XPS stylus in with the device, which effectively makes it $430 more competitive.

	Dell XPS 2-in-1	Surface Pro 9 i7
Geekbench 5 - Single-core (score)	1,685	1,215
Geekbench 5 - Multi-core (score)	7,022	6,630
Cinebench R23 - CPU (multi-threaded)	6,856	6,891
3DMark - Time Spy (score)	999	1,779
Geekbench 5 - Open CL (score)	14,174	17,905
Battery life - 1080p video playback (h:min)	07:07	08:29
CrystalDiskMark Read (MB/s)	5,078	3,502
CrystalDiskMark Write (MB/s)	3,952	2,527

■ W11 Home; 13-inch 500 nit touch display at 2880 x 1920 pixel resolution; Intel Core i7-1250U CPU; 16GB RAM; 512GB PCIe SSD; Folio Backlit Keyboard and XPS Stylus included;47Wh battery (7h7min 1080p movie playback); 29.3 x 20.1 x 0.74cm; 751g tablet, 1.314kg (inc keyboard folio).

This competitive inclusion does a lot to put the XPS 13 2-in-1 ahead of its competition, but there are a couple of caveats that go some way to counterbalance the full weight of that bonus. The first is a disappointing GPU performance with a lower clocked Intel Iris Xe Graphics GPU giving this device graphical performance between 20 and 45 percent lower than the i7 Surface Pro 9. Dell's included keyboard and trackpad are nice enough to use, but they lack more advanced features like offering an elevated keyboard angle and the stylus isn't overly ergonomic. These little niggles combine with a sub-optimal folio-based magnetic interval stand that works well enough, but which is a long way from the best tablet stand you can get in 2022.

Battery life is pretty good offering up to nine hours and 15 minutes in light work tasks which should get you through the better part of the work day, but it's still 10 percent behind the Surface Pro 9. The tablet itself is lighter than the Surface Pro 9, but it's 141g heavier as a package with the keyboard and stylus. The one area where the XPS does significantly outpace the incumbent 2-in-1 is storage speeds offering much faster 5,000/4,000MB/s read and write speeds. All up it's an amazing first attempt that is competitive if you're happy to live with limited tabletop screen positions and you don't care much for games.

"Dell bundles the Folio Backlit Keyboard and XPS stylus in with the device, which effectively makes it $430 more competitive. "

A solid alternative tablet 2-in-1 to the Surface Pro range.

Joel Burgess

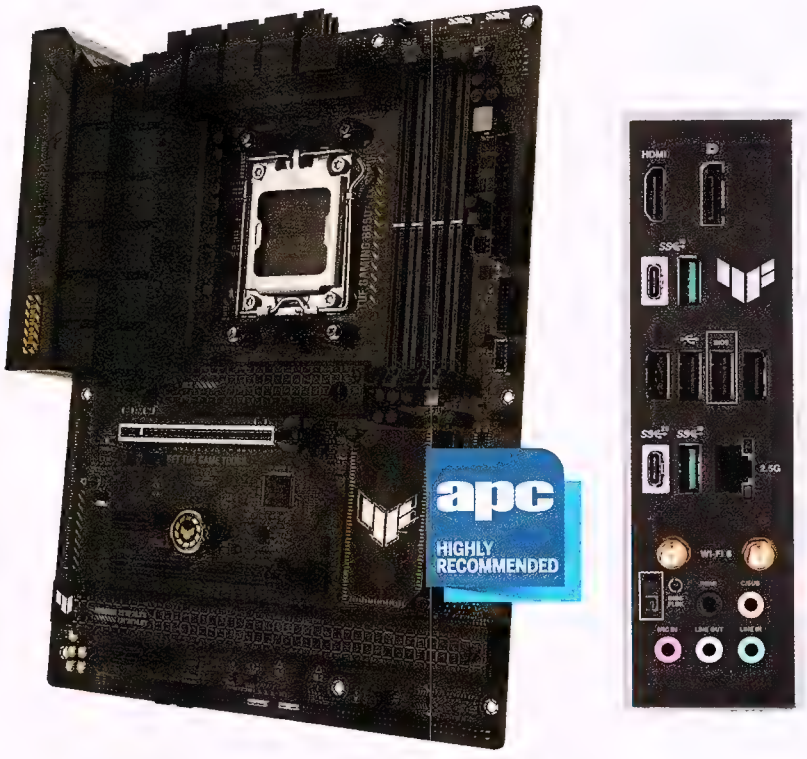
★★★★☆

MOTHERBOARD

Asus TUF Gaming B650 Plus WiFi

Looking for affordable AM5? B650 may be just what you're looking for.

■ $469 | www.asus.com



■ Asus TUF Gaming B650 Plus WiFi; Socket AM5; Supports AMD Ryzen 7000 series desktop processors; 3x M.2; 4x SATA; Up to 1x USB 3.2 Gen2x2, 3x USB 3.2 Gen 2, 3x USB 3.1 Gen 1, 8x USB 2.0; WiFi 6; Realtek 2.5G LAN; Realtek 7.1 Channel HD Audio; ATX Form Factor.

Though AMD's AM5 motherboards and Ryzen 7000 CPUs have a lot going for them, the pricing of high end motherboards is a weakness. Let's face it, $1,000+ X670E boards aren't going to attract many buyers. Fear not! AMD's B650E and B650 motherboards are plentiful, bringing Socket AM5 down to an affordable price point.

B650/E differs from X670/E in that it comes with just one 'chipset' as opposed to the two of X670/E. This means B650 has fewer PCIe 4.0 lanes and a generally trimmed down I/O. Unlike B650E, B650 boards forgo PCIe 5.0 graphics support, with most retaining PCIe 5.0 M.2 support. The Asus TUF Gaming B650 Plus WiFi is just such a board.

The TUF B650 costs around $469 at the time of writing. That's not what you'd call cheap, but the Asus comes with a good feature set for its price. Note that Asus offers cheaper mATX versions of the TUF B650, along with non-Wi-Fi versions too.

The board comes with the trademark TUF black finish with yellow highlights. RGB is absent, though there are four headers on board. For your storage needs, the board comes with three M.2 slots and four SATA ports. The M.2 heatsinks are adequate, though they aren't as chunky as those you'll find on more expensive boards.

The VRM isn't anything spectacular, though a 12+2 phase design with 60A stages and 8+4 pin power was enough to power our 7950X without issue. Where the board really impresses is its VRM heatsink assembly. The big and chunky heatsinks do a great job. Well done Asus.

The TUF B650 comes with a good set of rear I/O ports. A USB 3.2 Gen 2x2 Type-C port is joined by another three 10Gbps ports and four USB 2.0 ports. You get 2.5G LAN and WiFi 6, though notably not 6E if that matters to you. It's good to see HDMI 2.1 and DP 1.4 ports. They'll be particularly welcome if AMD chooses to release Zen 4 APUs in the future.

When it comes to benchmarking, most boards perform within a margin of error. Results with our 7950X CPU were very competitive with more expensive X670E boards. It's also well worth having a play with Asus' enhanced PBO modes which allow you to easily tinker with power levels or tune the system to match your cooling.

Some boards still trip up when it comes to support for very fast EXPO memory. Our G.Skill DDR5-6000 C30 and it worked perfectly. That's a testament to Asus' BIOS team, which can usually be relied upon for up-to-date RAM compatibility.

What does a typical user want from a 2023 motherboard? Consider things like a decent VRM, WiFi 6, PCIe 5.0 SSD support and 20Gbps USB. The Asus TUF Gaming B650-Plus WiFi ticks these boxes. If you can live without WiFi 6E and PCIe 5.0 GPU support, it's the kind of board that will surely be popular. And like all AM5 motherboards, it will have a long life with plenty of upgrade potential. To be fair, there are many competing motherboards in this price range, but if you're a fan of Asus, you'll be happy with the TUF Gaming B650-Plus WiFi.

	Asus TUF Gaming B650-Plus WiFi	Asrock X670E Pro RS
Cinebench R23 - Multi thread Score	38,334	38,154
Blender 3.2 Whitelands - Time (seconds) Lower is better	401	404
7Zip - Billion Instruction per second	225.69	224.97
Handbrake 1.6 - 4K 10-Bit HEVC to 1080p FPS	129.1	128.7
3DMark TimeSpy Extreme - Score	18,183	18,119
Ghost Recon: Breakpoint - 1080p, Low, Avg FPS	306	312
Metro: Exodus Enhanced - 1080p, Ultra Preset, Avg FPS	162	161

The TUF B650 Gaming Plus is a solid AM5 entry. It's got a good core feature set though there is tough competition in this price range.

Chris Szewczyk

★★★★☆

CPU

AMD Ryzen 5 7600

Zen 4 reaches the mainstream.

■ $379 | www.amd.com

AMD has traditionally offered some excellent value for money CPU options, particularly when combined with its B series motherboards. But for several reasons, that hasn't been there since the release of Ryzen 7000 and accompanying B650 motherboards. The Ryzen 5 7600 CPU is one piece of the puzzle that's needed to bring the performance of Zen 4 down to a lower price point.

The Ryzen 5 7600, like all Ryzen 7000 series CPUs, is built with the recently released Zen 4 architecture. It's a chiplet based design with a 5nm core compute die (CCD) and a 6nm I/O die. AMD claims the Zen 4 architecture delivers an average 13 percent IPC improvement over previous generation Ryzen 5000 processors. It includes RDNA 2-based integrated graphics, supports PCIe 5.0 and DDR5 memory, and it requires the purchase of a socket AM5 motherboard.

The Ryzen 5 7600 is essentially a cheaper 7600X with lower clocks and a lower TDP. It comes with six cores and twelve threads with a base clock of 3.8GHz and a boost clock of up to 5.1GHz. This compares to the 7600X with its much higher 4.7GHz base clock and 5.3GHz boost clock. The amount of cache remains the same, with 6MB of L2 and 32MB of L3.

The key specification of the 7600 is its lower TDP, at 65W (or up to 88W total package power), this is much lower than the 105W (up to 142W) of the 7600X. This definitely addresses the concerns we have around the high heat output of the X series CPUs, which can easily push over 90 degrees Celsius.

The 7600 is priced at $379. But at the time of writing, several big-name vendors were selling the 7600X for as low as $399. That's too small a difference between the two. It's important to bear in mind that the 7600X requires an aftermarket cooler, whereas the 7600 includes a basic, but acceptable Wraith Stealth. Still, with the 7600X rapidly falling in price, the 7600 is sure to fall too.

"The 7600 holds up very well in gaming, even notching up some wins against the 13600K."

■ AMD Ryzen 5 7600; Socket AM5; 6 core/12 thread; 3.8GHz base/5.1GHz boost clock; 32MB L3 cache; Supports DDR5-5200; 65W TDP.

When it comes to performance, the 7600X with its 12 threads can't compete with the 13600K at multi-threaded loads, though in fairness, that's a more expensive CPU. Even the i5 13400 is more expensive. However, the 7600 holds up very well in gaming, even notching up some wins against the 13600K. It's very much game dependent though. Some engines still run better on CPUs with lower core counts.

The real strength of the 7600 becomes apparent when looking at system power consumption. At peak reading of 154W under an all core Cinebench R23 load is outstanding. Though not dramatically lower than the 7600X at 196W, it's nearly half that of the higher TDP processors.

The 7600 is a very good CPU, but overall platform affordability and competition from Intel and AMD's own AM4 platform remains strong. Thankfully, the AM5 platform has a lot of upgrade potential ahead of it.

A CPU like the 7600 will perform well at tasks that don't require loads of multithreaded grunt, including gaming. If you're on a budget, saving some money on a CPU like the 7600 and putting it towards a faster graphics card will leave you a happy gamer.

The 7600 offers affordability, power efficiency and excellent performance, though the enduring AM4 platform and Intel's i5-13400 provide tough competition.

Chris Szewczyk

★★★★☆

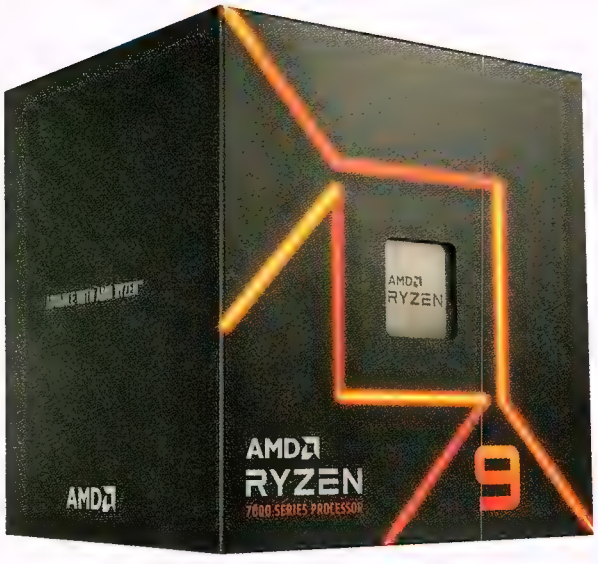
	Handbrake 1.6	Cinebench R23	Cinebench R23	Blender 3.3 Whitelands	7Zip 22.01	Peak System Power Consumption
	Video conversion 4K to 1080p FPS	Rendering - Multi thread Score	Rendering - Single thread Score	Render Time (seconds) Lower is better	File Compression - Billion Instructions per second	Wall Draw (watts)
AMD Ryzen 9 7900X	118.2	29,217	2,013	535	179.96	286
AMD Ryzen 9 7900	106.4	24,471	1,963	616	164.95	157
AMD Ryzen 5 7600X	76.6	15,389	1,919	988	101.22	196
AMD Ryzen 5 7600	71.3	14,083	1,860	1030	103.19	154
Intel Core i5-13600K	104.1	23,728	2,012	712	132.38	278

CPU

AMD Ryzen 9 7900

More threads. Fewer watts.

■ $689 | www.amd.com



apc EDITOR'S CHOICE

"If you need some extra performance, you can do away with the 65W limitation and essentially turn the chip into a fully-fledged 7900X."

■ AMD Ryzen 5 7900; Socket AM5; 12 core/24 thread; 3.7GHz base/5.4GHz boost clock; 64MB L3 cache; Supports DDR4-5200; 65W TDP.

The Ryzen 5 7600 is an impressive chip for users on a budget, but it's just one of three 65W CPUs that AMD launched in January. The others are the Ryzen 7 7700 and the Ryzen 9 7900. We have the latter chip on hand for a review and if it's anything like the 7900X, it's going to be a powerful chip, but will its 65W TDP constrain it too much?

The Ryzen 9 7900 is a Zen 4 chip with two 5nm Core Compute Dies and a single 6nm I/O die. It can be thought of as a doubled 7600X. That means it has more cache, with 12MB of L2 and 64MB of L3. The 7900 has a 3.7GHz base clock and a 5.4GHz boost clock. That's 1.0GHz and 200MHz lower than the 7900X, so it's clear the 7900 is substantially restricted in order to stay within that 65W budget (up to 88W total package power).

The 7900 will set you back $689, while the 7900X costs $739, though it's been discounted below that. $50 isn't a major difference, though you do get AMD's Wraith Prism cooler with the non-X. It's a capable cooler, but not ideal if you plan to run 24 threads under heavy loads for extended periods.

The 7900's efficiency is revealed when running heavily multithreaded benchmarks. It beats out the (admittedly cheaper) 13600K and does so while using much less power. And that's the true strength of the 7900. A full system power consumption peak reading of 157W is outstanding. Compare that to the 286W of the 7900X and it's like we're looking at an entirely different CPU.

The gaming performance of the dual CCD chips can suffer a little depending on the game engine, though a few frames here or there isn't a deal breaker.

There's an interesting option for users of the 7900, and the other non-X CPUs too. AMD's Precision Boost Overdrive allows you to manually set the TDP of any Ryzen 7000 chip. That means if you need some extra performance, you can do away with the 65W limitation and essentially turn the chip into a fully-fledged 7900X. We used Cinebench R23 as an example. A 7900X scores around 29,217 while the 7900 scores 24,471. That's quite a drop due to power limitations. However, by enabling PBO, the 7900 scores 28,613 – erasing most of the gap. You'll need to make sure you have good cooling though if you plan to overclock.

The Ryzen 9 7900 is another excellent CPU but many of the same conclusions we made with the 7600 also apply here. It's a little too expensive versus the 7900X, while Intel has strong competitors in the form of the 13700 and 13700K. Buying a CPU at near enough to $700 means your budget can surely accommodate an AM5 motherboard and DDR5 too, but then there's also the option of a 5950X on the AM4 platform. And AMD's ECO mode can turn an X CPU into a 65W one, too.

If you value power efficiency, the 7900 is simply awesome and with PBO you can get all the performance of a 7900X if you choose. We hope AMD (and Intel) continue to provide options for users that believe performance should not come at any cost. Long may the 65W desktop CPU continue.

The Ryzen 9 7900 delivers outstanding performance per watt and it overclocks very nicely too.

Chris Szewczyk

★★★★½

3DMark TimeSpy Extreme		Civilization VI			Ghost Recon: Breakpoint	Metro: Exodus Enhanced Edition	
Overall score	CPU Score	1080p, Ultra, DX12, Avg FPS	1080p, Ultra, DX12, Min FPS	1080p, Ultra, DX12, AI Turn Time	1080p, Low, Avg FPS	1080p, Ultra, DX12, Avg FPS	1080p, Ultra, DX12, Min FPS
17,023	9,807	385	309	5.59	304	159.7	93.2
16,145	8,121	361	295	5.64	295	152.6	89.4
13,786	5,191	312	248	5.90	296	165.0	91.9
13,314	4,731	297	237	5.92	290	160.6	89.9
16,036	8,036	373	312	5.73	277	158.3	90.7

CASE

Thermaltake Ceres 500 TG ARGB

A premium case packed with practicality.

■ $299, plus optional $169 LCD kit | www.thermaltake.com.au

■ Materials: Steel, tempered glass; Dimensions: W: 245mm H: 525mm D: 508mm; Weight: 10.5 Kg; Front I/O Ports: 1x USB 3.1 Gen 2 Type-C, 2x USB 3.1 Gen 1, 2x 3.5mm headset jacks; Cooling: 4 x CT140 140mm fans (3 x front, 1 x rear)

If you're after a high-quality case to house a 2023 build, there are two key criteria to keep in mind. Heat and capacity. CPUs need capable cooling, and graphics cards, well, they're big! Your choice of case is more important than ever. Enter the Thermaltake Ceres 500 TG ARGB. At $299 it's a premium case designed with just these things in mind.

The Ceres 500 is a mid-tower with a steel construction and tempered glass side panel. Our sample is the snow version, though it's also available in black. At 525 x 245 x 508mm it is close to full tower territory. It weighs in at 10.5KG. Along with its quality feet, size and weight, it has a really solid feel about it which is good for vibration dampening. It comes with a GPU sag prevention mechanism, or you can mount your GPU vertically if you want.

The case is covered with perforations to aid airflow. It's able to house a 420mm top mounted radiator plus a front mounted 360mm one meaning it'll have no problem handling the hottest components. There's plenty of dust filtering too. Thermaltake includes its excellent CT140 ARGB fans, with three at the front and one at the rear. At around $30 each, they're responsible for a big chunk of the Ceres 500's $299 asking price.

We love the side mounted I/O ports of the Ceres 500. Cases with side windows are much more likely to be placed on the right-hand side of your desk and having the ports easily accessible is a great design choice. These ports consist of a USB 3.2 Gen 2 Type-C, a pair of USB 3.0 Gen 1, mic and headphone ports plus the power and reset buttons.

Special mention has to go to the door hinge. It's very sturdy and holds the door securely. It's a small thing but it's the kind of little feature that adds a lot to the overall excellent build quality of the Ceres 500.

Thermaltake offers an optional 3.9-in LCD panel which can be mounted at the bottom below the I/O ports. It can be used to display things like monitoring information, the weather or your own GIF images. It can be integrated with other Thermaltake components with the TT RGB Plus software. It's expensive at $169, and while it looks great, it's a niche product.

The build process was easy, with lots of space around the motherboard, AIO and power supply area. It housed a 356mm long Zotac RTX 4080 Airo graphics card with plenty of room to spare. There's plenty of cable management options, velcro ties and holes for as many zip ties as you like. The end result is a system that looks every inch a premium build. The LCD panel and ARGB of the system really stand out in our white example.

The Thermaltake Ceres 500 gets a big tick from us. Though the competition is tough once you get into this price range, TT shows it can compete with the best. The hottest and largest graphics cards are tamed, the fans are excellent and it's packed with high quality cable management touches and attention to detail. Well done Thermaltake!

The TT Ceres 500 is a very well-built case packed with useful design choices. It's a great option for a high end 2023 build.

Chris Szewczyk

★★★★½

CASE

MSI MPG Velox 100P Airflow

A clean and simple case that lets the air in.

■ $190 | msi.com

■ Materials: Steel, tempered glass; Dimensions: W: 231mm H: 490mm D: 474mm; Weight: 8.7 Kg; Front I/O Ports: 1x USB 3.2 Gen 2 Type-C, 2x USB 3.2 Gen 1, 2x 3.5mm headset jacks; Cooling: 4 x 120mm fans (3 x front, 1 x rear).

MSI has been going hard with expanding its range of cases, and its designers have learned much from some early mis-steps. Airflow was sometimes an issue with many early MSI cases, and indeed the company still favours solid front panels in many models, but we're increasingly seeing mesh or grille fronts – and this Velox 100P 'Airflow' is indeed a version of the standard glass-front 100P with an open grille.

Another huge general improvement is access. The 100P uses a hinged tempered glass door with a magnetic latch. Simplicity and ease. Nice.

It comes with a vertical graphics card mounting bracket, though you'll need to find a PCIe riser cable yourself (around $80 on Amazon), as there's none in the box. Using it will cover all the PCIe slots on your motherboard though, so if you need to add any other cards its use is not an option.

The case comes with three 120mm fans on the front, which are not RGB, though the included rear exhaust 120mm fan does have the RGBs. There's an RGB strip along the side of the PSU area of the case, and two more RGB areas at the top and bottom of the front grille. These can be colour- and mode-cycled via a switch at the top of the case, or with your favourite compatible RGB app.

Along the top for connectivity there's a standard pair of USB 3.2 ports, and a USB 3.2 Gen 2x2 Type C, along with mic and headphone jacks. Two SATAs can be mounted on the back of the motherboard tray, and there's an easily removable HDD bay.

There's room for a 360MM AIO cooler along the top, or on the front. But only barely if you choose to use 140mm fans in the front instead of the supplied 120mm fans. We installed a 360mm radiator along the top, and there was very little clearance for the swapped out 140mmm front fans. They all fitted, but it was a squeeze. Another 5mm in height and depth for this case would have ensured a perfect fit. That said, if you just use the supplied 120mm front fans you won't run into any issues.

If you want to use a 240mm AIO the radiator can also be mounted on the back side panel, though with it there you won't have room for any front fans at all.

The case size is big enough to accommodate even the largest RTX 4090 with room to spare. Up to a 380mm length can be installed, and that leaves room to spare for the front fans too.

Building in the Velox 100P Airflow was a no-hassles affair. The fit and build quality is absolutely fine, though it was easy to scratch the paint, so be careful of that. It offers excellent cooling and can shift vast amounts of air through its unobstructed and open interior. Cable management inside the rear panel is also good, with plenty of depth to squeeze your mess in there, and three Velcro straps to keep your tangles tidy. Its looks are refined, elegant and pleasing to the eye with little design flourishes – which is becoming something of a hallmark for MSI cases.

A good looker that's nice to build in, though some corners have been cut with some plastic pieces and no PCIe riser cable is included.

Ben Mansill

★★★★☆

GRAPHICS CARD

MSI GeForce RTX 4070 Ti Gaming X Trio

A mid-range GPU with a high-end price.

■ $1,599 | www.msi.com

Slowly but surely, Nvidia's Ada Lovelace architecture is coming down to lower price points, though at over $1,500 it's very much relative! The first of two cards we have for review is MSI's RTX 4070 Ti Gaming X Trio. It sits in the middle of MSI's GPU range, between the Ventus and Suprim ranges.

The MSI, and indeed the Gigabyte 4070 Ti contain the third Ada Lovelace GPU to be released, the AD104. It's a 4nm GPU with all of its features enabled. It includes 7,680 cores, 60 RT Cores and 240 Tensor Cores. MSI set the boost clock of the Gaming X Trio to 2,745MHz, a decent increase of 135MHz over the Nvidia reference speed.

The card comes with 12GB of 21Gbps GDDR6X memory connected to a 192-bit bus. That bus is a step back from the 256-bit bus of the 3070 Ti. The MSI features an entirely reasonable 285W TDP with power provided by a single 16-pin 12HPWR power connector. Display outputs are the three standard DP 1.4 ports plus one HDMI 2.1 port. DP 2.0 is missing from the Ada generation.

The Gaming X Trio comes with a custom PCB, including a 10+2 phase VRM. We wouldn't call that extreme but then it's not needed for a GPU with a 285W TDP. The card includes dual BIOS, but the default gaming option is all you'll need. The silent mode doesn't deliver any tangible difference to our ears.

MSI Gaming X cards have historically impressed us with their very good blend of cooling ability and low noise levels. And with a peak temperature of 66 degrees with essentially silent noise levels, MSI again gets it right. The Gigabyte card is much cooler, but it's also louder, without delivering any tangible extra performance.

At $1,599, the primary competition for the 4070 Ti is the AMD RX 7900 XT, plus the 3080 and 3090 cards from Nvidia's previous generation. The 4070 Ti is a very good 1440p card, delivering 60FPS in *Cyberpunk 2077* with ray tracing without even enabling the ever impressive DLSS. It's capable at 4K though its memory bus appears to hurt it at higher resolution.

If you value ray tracing and DLSS, the 4070 Ti is a capable and efficient card, but the 7900 XT pulls ahead at traditionally rendered titles. It all comes down to what games you play and what features matter to you.

It's too bad that GPU pricing is the way it is, even after the end of the mining boom. $1,599 for a xx70 card is a lot of money. Nvidia is surely making a killing off of these GPUs. Still, it's a card that beats the 3080 Ti in performance while costing less. When viewed in those terms, the 4070 Ti isn't a bad proposition.

Price aside, the RTX 4070 Ti is a fine GPU, and the MSI Gaming X Trio is one of the better ones. It blends performance, cooling capacity and build quality into a well-balanced package. You'll save a few dollars over the top tier models such as the Asus Strix or MSI Suprim, as the 4070 Ti is really a mid-range GPU with a high-end price. In a year from now, let's hope these prices were all just a dream.

■ MSI GeForce RTX 4070 Ti Gaming X Trio; 7680 CUDA cores; 2745MHz boost clock; 12GB GDDR6X 21Gbps memory, 504.2GB/s memory bandwidth; 3x DisplayPort 1.4a, 1x HDMI 2.1; 285W TDP, 1x 16-Pin power connector.

The MSI Gaming X Trio extracts the maximum from the 4070 Ti at incredibly low noise levels. But like all 4070 Ti's it's too expensive at this point in time.

Chris Szewczyk

★★★★☆

	Metro: Exodus Enhanced Edition				F1 2021			
	2560x1440 Extreme Preset		3840x2160 Extreme Preset		2560x1440 Ultra High Preset		3840x2160 Ultra High Preset	
	Min	Avg	Min	Avg	Min	Avg	Min	Avg
MSI GeForce RTX 4080 Suprim X	69	95	40	54	175	202	99	117
MSI GeForce RTX 4070 Ti Gaming X Trio	52	74	31	42	142	166	77	93
Gigabyte GeForce RTX 4070 Ti Gaming OC	51	75	32	42	141	166	77	93
Nvidia GeForce RTX 3080 Ti	48	67	29	39	131	153	76	89
AMD Radeon RX 7900 XT	47	66	28	36	118	147	68	87

GRAPHICS CARD

Gigabyte RTX 4070 Ti Gaming OC

A slightly more affordable 4070 Ti.

■ $1,499 | www.gigabyte.com

It's safe to state that the RTX 4070 Ti is a mid-range card hiding beneath a high-end price. Premium tier cards like the Aorus Master or MSI Suprim really are overkill for this class of GPU. A card Gigabyte RTX 4070 Ti Gaming OC might not appeal like the flagship options, but it's got it where it counts.

As is the case for all RTX 4070 Ti's, the Gigabyte includes the 4nm AD104 GPU, with 7,680 cores, 60 RT Cores and 240 Tensor Cores. The Gaming OC version comes with a small factory overclock at 2640MHz though as we saw in testing, the card boosts a lot higher than that in reality.

It comes with 12GB of 21Gbps GDDR6X memory connected to a 192-bit bus. We can't get used to the fact that a card that costs $1,499 comes with a 192-bit bus. Let's hope that the 4060 class cards aren't excessively hobbled. The TDP of the card is 285W, with power provided by a single 16-pin 12HPWR power connector. Display outputs are the standard three DP 1.4 ports plus one HDMI 2.1 port.

The Gaming OC includes an RGB lit logo, but the real highlight are the fans with RGB mounted directly onto them. They only light up when the fans are spinning. It's the kind of card that demands the use of a vertical GPU mount. The card has a vapour chamber cooler with seven heatpipes. There are plenty of thermal pads for the VRM and memory. The rear of the card is totally open, allowing heat to pass through the fins and into the path of front to rear case airflow.

The Gaming OC PCB incorporates a 10+2 phase VRM. There's no need for a fancy VRM with 20 or more stages that will never be utilized.

The 4070 Ti goes up against the RX 7900 XT, doing well in games with ray tracing enabled, though the 7900 XT is strong at raster workloads. Interestingly, the semi-irrelevance of the rated boost clock is revealed. The card was happy to sit right on 2,850MHz for long term loads, which is much higher than the official 2,640MHz clock. The card clearly has enough power and cooling headroom to let it fly.

■ Gigabyte GeForce RTX 4070 Ti Gaming OC; 7680 CUDA cores; 2640MHz boost clock; 12GB GDDR6X 21Gbps memory, 504.2GB/s memory bandwidth; 3x DisplayPort 1.4a, 1x HDMI 2.1; 285W TDP, 1x 16-Pin power connector.

However, there is a cost, and that's the noise level. Though it cannot be described as loud, the Gigabyte is definitely audible, but the advantage of that is a load temperature of just 58 degrees. 58! That's very good, though It seems as though Gigabyte was too aggressive with the fan profile. If you find it to be too noisy, do engage the silent BIOS profile. This is one of the few instances we can recall where a secondary BIOS made a meaningful difference.

Our conclusion is much the same as it would be for any other 4070 Ti. At $1,499 it's still too expensive, but the Gaming OC doesn't have quite the same sticker shock as a premium tier card. When viewed in isolation, the 4070 Ti and the Gaming OC are capable and efficient gaming cards. If value for money is key to you, then the $100-$200 saving over more expensive models will deliver a card that loses out on little, if anything.

The Gigabyte Gaming OC isn't silent, but it loses next to nothing compared to 4070 Ti's costing more.
Chris Szewczyk

★★★★☆

	Ghost Recon: Breakpoint				Cyberpunk 2077				3DMark
	2560x1440 Ultimate Preset		3840x2160 Ultimate Preset		2560x1440 RT Medium Preset		3840x2160 RT Medium Preset		Time Spy Extreme overall
	Min	Avg	Min	Avg	Min	Avg	Min	Avg	
	146		96		62	76	31	37	13193
	125		78		49	60	24	28	10709
	125		79		50	60	24	28	10751
	119		81		50	60	24	30	10142
	156		93		24	58	16	29	11900

Windows 7, 8.1, 10 or 11 | https://picpick.app

PICPICK 7.0

Screen-Capture tool.

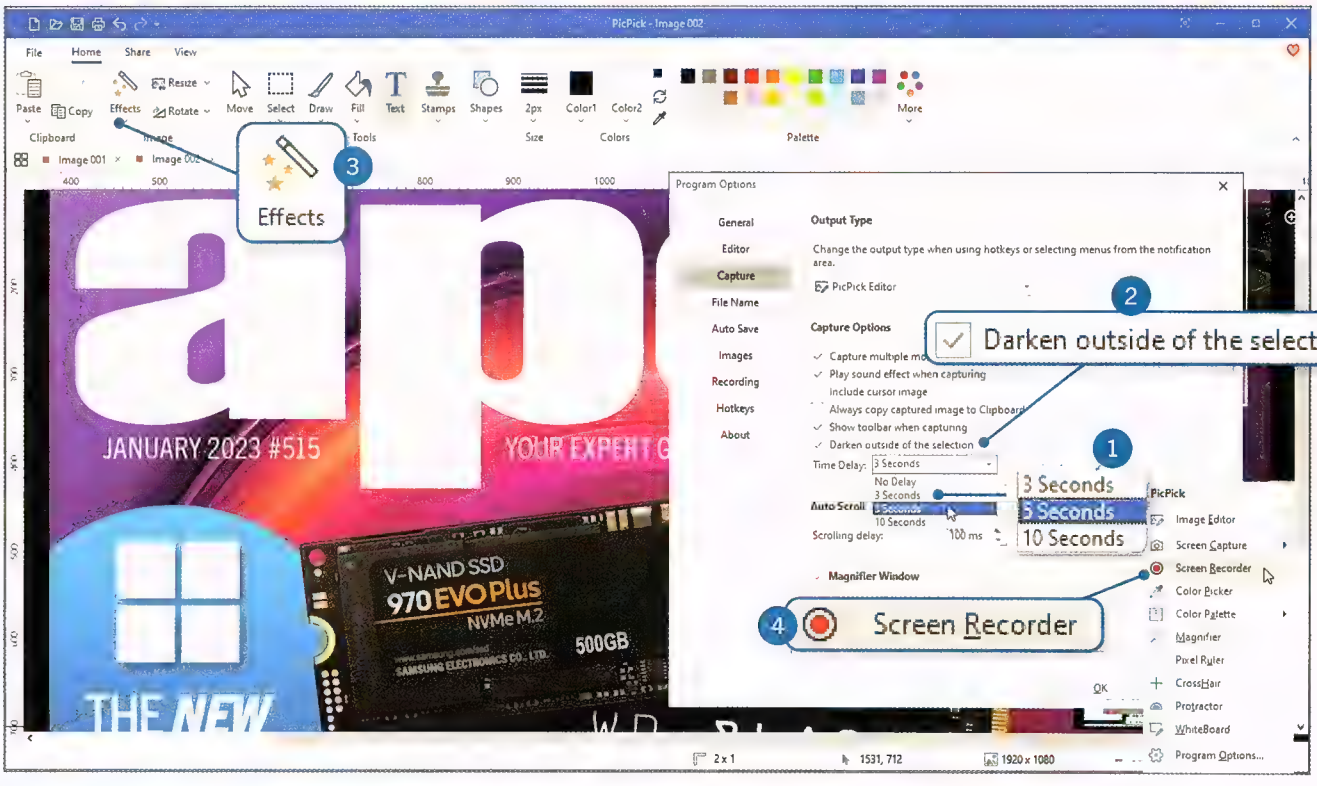
The developer of this brilliant tool for capturing and editing screenshots has been very busy this year. PicPick 6, released in March, completely redesigned the program's interface and added a dark mode, while version 6.2 in June introduced a feature called Screen Recorder that lets you capture videos and animated GIFs of your screen, including audio. To round off 2022, PicPick has been updated again with even more great features, to strengthen its status as the best free (for personal use) software of its kind.

The most notable addition in PicPick 7.0 is the ability to delay capturing screenshots by three, five or 10 seconds. This is very useful when you want to illustrate a specific action, or capture content that's not currently visible, because it gives you time to prepare before the image is saved. There are several ways to access this new feature: click the settings cog next to Screen Capture on PicPick's Tasks screen and choose an option from the Time Delay menu; click Options, select Capture and specify the time delay under Capture Options; or right-click the PicPick taskbar icon and choose Screen Capture, then Time Delay.

When you press the hotkey to capture a screenshot – by default these are Print Screen to capture your entire screen and Alt-Print Screen to capture the current window – PicPick will wait for the specified number of seconds before saving the image. A countdown timer will appear in the bottom-right corner of your screen.

> "The most notable addition in PicPick 7.0 is the ability to delay capturing screenshots by three, five or 10 seconds."

Another new feature darkens the area of your screen that won't be included in the screenshot, which is handy when you only want to capture a particular area. Other changes include improved capturing of scrolling windows, which allows you to save screenshots of whole web pages, and the addition of Screen Recorder to the taskbar menu.



1 PicPick 7.0 lets you delay capturing screenshots by three, five or 10 seconds. Activate this feature by selecting Capture in the Program Options panel and choosing your preference in the Time Delay menu.

2 Another change darkens the area of your screen that's not selected for inclusion in a screenshot. This option is enabled by default, but you can switch it off by unticking the box next to 'Darken outside the selection'.

3 Click the Effects button to edit the screenshots you capture in PicPick. Options include adjusting the brightness, contrast and colour; sharpening, blurring or pixelating the image; and adding a watermark.

4 Right-click the PicPick icon in your system tray to quickly access its screen-capture tools and other main options. These now include Screen Recorder, which lets you record videos and GIFs of what's on your screen.

Various licences available | https://voyagerlive.org

VOYAGER LIVE 22.10

Nate Drake explores the glorious union of Gnome and Xfce in a single OS. You'll never look at your desktop the same way again.

Voyager's desktop is exotic but clean and efficient. You can tweak it further with BoxVoyager, provided you ignore translation errors.

In 1901, chef Julia Chandler pioneered the first peanut butter and jelly recipe. What once were two delicious spreads in their own right had now been combined into one of the greatest sandwiches of all time.

French developer Rodolphe Bachelart has pioneered his Xubuntu-based Voyager Live OS in a similar way, bringing together both Gnome 43 and Xfce 4.16.

This version is based on Ubuntu 22.10 (Kudu). As can be expected with a system with two pre-installed desktops, the ISO weighs in at a hefty 3.8GB. This means a much longer installation process than regular flavours of Ubuntu. Still, this is done via the regular Ubiquity installer, so there are no surprises. The Voyager website also offers pre-packaged live versions to run on USB via Mintstick or UNetbootin. The ISO can also be run in live mode.

For your extra gigabytes, you also get a large number of pre-installed applications that tie in with the developer's philosophy of making the OS customisable. Voyager has the usual suspects, such as LibreOffice and Firefox, as well as the RhythmBox media player, GIMP and the GoodVibes internet radio player.

On first boot, you're given the choice of logging in to Ubuntu, Ubuntu on Xorg, and Xfce. Applications are simple to navigate: the fixed Plank dock contains a roundup of default apps consisting of flat Mac OS-like icons. Click Show Applications to see them all. From here you can flick between desktops via Xfdashboard.

The full app list includes a good crop of games, including the brilliantly named *Bastard Tetris*. Bachelart seems to take gaming seriously, using the Voyager website to show off a gaming spin using Wine and Steam to play *Cyberpunk 2077*.

Voyager also seems to take privacy seriously. It contains the Gnome Encfs manager, which can be accessed via the top panel to encrypt folders and drives. You can also launch Firefox in private browsing mode directly from the app menu.

The OS comes with BoxVoyager Gnome, Voyager's very own app for configuring Conky and other utilities to use widgets and themes. The OS comes with a respectable list of pre-installed themes and icon sets. The traditional Gnome-tweaks tool is also there if you prefer. We used it to change the rather bizarre default 'oreo' mouse icon, but you can also view the colossal list of built-in themes and backgrounds.

Ultimately, the proof of the pudding is in the eating. Does this combination of Gnome and Xfce elements work? We'd say on the whole it does. The interface is intuitive and very customisable. Apps are easy to locate and launch. Voyager is perfect if you want a beautiful operating system with a smorgasbord of pre-installed programs.

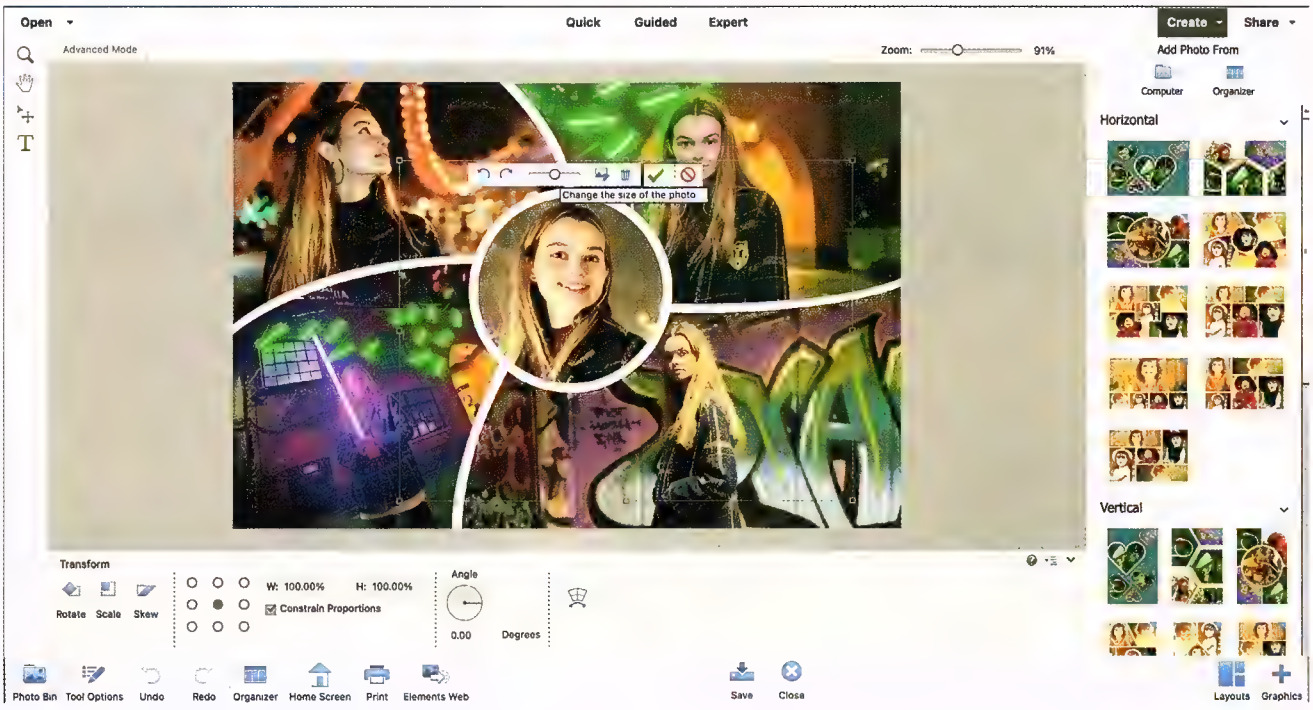
Needless to say, combining all these elements together comes at a cost. You can't help but notice this, as by default the desktop shows a Conky system resource readout of your CPU usage and HDD space. (Though we note the OS, once installed, only takes up 13GB rather than the recommended 25GB.)

Also, while we at APC speak fluent Franglais, other users may become frustrated with the number of app descriptions still in French. Although there are tutorials on using the OS available on the website, the layout and wording is sometimes difficult to follow. When we clicked the forum link, we also found it was closed. This is one major area where Voyager Live falls down, which is a shame given the care and effort that's been put into marrying together the best of two desktop environments.

Voyager Live is very elegant and customisable but is let down by translation issues and a lack of good documentation.

Nate Drake

★★★½☆



macOS 11, macOS 12 (12.4 or later); Windows 10/11 | $145.19 | adobe.com

ADOBE PHOTOSHOP ELEMENTS 2023

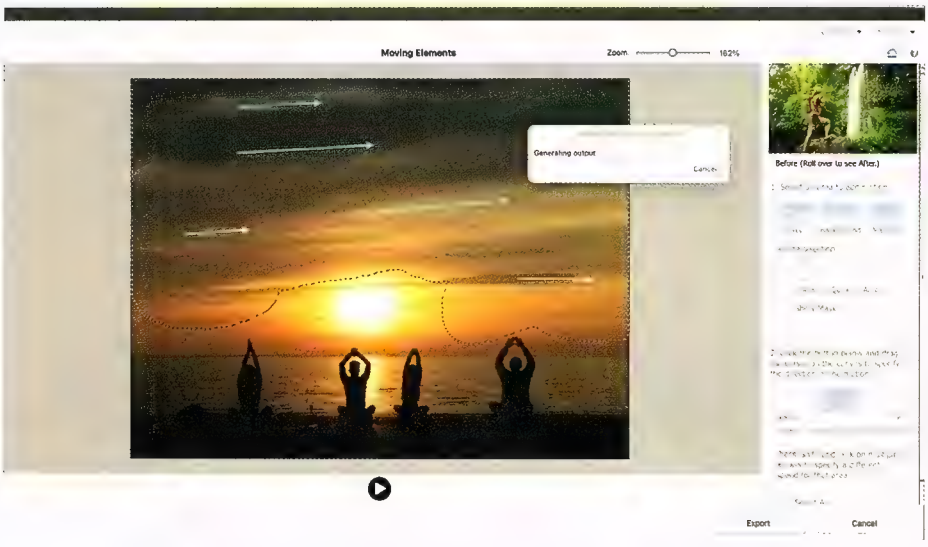
Fix your photos and create eye-catching social media content.

A new selection of contemporary collage templates enables you to combine and share eye-catching images via social media.

The new Moving Elements command enables you to make areas such as clouds move in precise speeds and directions to create animated GIFs.

Photoshop Elements 2023 is designed to help photographers create eye-catching images with the minimum of time and effort. It focuses on overcoming common photo problems such as revealing missing tonal detail or removing unwanted objects. Thanks to the Adobe Sensei AI machine learning technology it also enables you to give your images a creative makeover without requiring years of experience using the full version of Photoshop (Photoshop CC). In times when budgets are tight Photoshop Elements 2023's one-off purchase price should make it an attractive alternative to Photoshop CC's rolling monthly subscription costs.

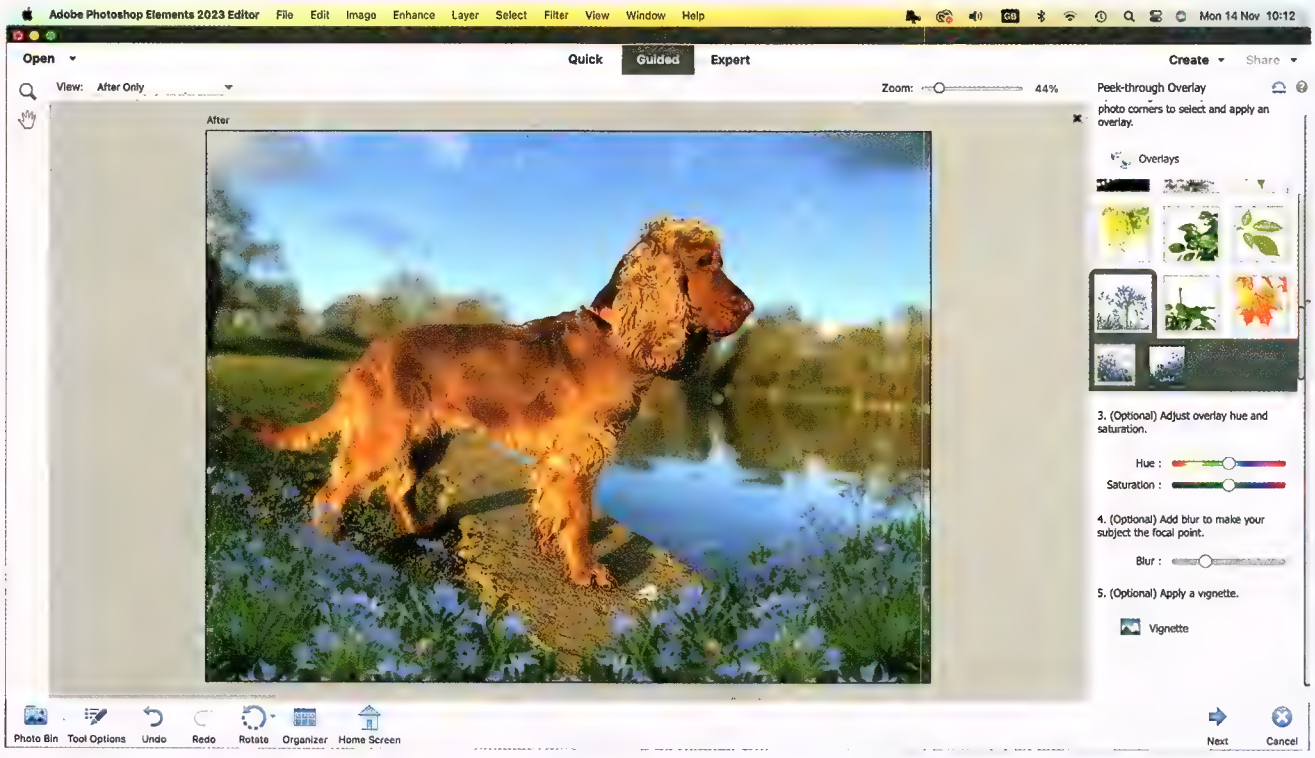
Unlike the black and dark grey panels of most current photo-fixing apps (including Photoshop CC), Photoshop Elements 2023 still sports the light grey workspace that it has worn for many years, giving it a dated look. The large icons and buttons might be better suited in an app aimed at children, but the simple look could be reassuring for newcomers to photo editing and image manipulation. The lack of change to the workspace design may also encourage regular Photoshop Elements users to update to the latest version as they won't need to spend time adapting to a new layout.



As with previous incarnations, the Photoshop Elements 2023 workspace is divided into three sections: Quick, Guided and Expert. The Quick workspace features an Adjustments panel that lets you fix exposure and colour problems in seconds by clicking on preview thumbnails. You can then fine-tune the adjustments with a slider.

The Guided Edit workspace helps image editing newcomers to perform a range of practical or creative edits by taking them step-by-step through range of creative techniques such as how to correct skin tone or remove unwanted objects from a shot. Once you've created a composite image using a Guided Edit you have the option of fine-tuning it in the Expert editing mode which gives you access to extra tools such as layers and masks.

Guided Edits have always been one of Photoshop Element's strong points and the



The new Peak-Through Overlay Guided Edit enables you to add foreground interest for a more effective composition.

latest version features a welcome new addition called Peek-Through Overlay. This enables you to enhance a photo by adding assets such as Autumnal leaves to the foreground of the image. You can blur these foreground objects to create a shallow depth of field effect that helps focus the eye on the main object.

The new Moving Elements menu command isn't available in the Guided Edit workspace but it does provide step-by-step instructions on how to select part of a photo and animate that particular section. This enables you to create a .gif or .mp4 movie that features moving clouds or flowing water in a few clicks.

Creative sharing

Existing Guided Edits such as Perfect Landscape have been upgraded, so you now have 36 skies to add to a shot instead of the 12 that shipped with Photoshop Elements 2022. It's now even easier to replace a landscape's bland sky with a stunning sunset (or you can even add an elusive aurora borealis). You can also use the Perfect Landscape Guided Edit's brush-based tools to fine-tune where the new sky joins your landscape's horizon without needing to access and edit a layer mask directly in the Expert workspace.

When it comes to sharing your favourite shots you can take advantage of an update to the Photo Collage menu. You can now combine a series of shots in more creative ways thanks to a new series of contemporary templates. You can browse square, vertical, horizontal and panoramic collage templates to suit a variety of social media or print destinations.

The Photoshop Elements Organiser enables you to take control over your ever growing collection of clips and stills by adding keywords or colour ratings to them so you can find favourite files more quickly. You can then launch Photoshop Elements to edit your photos or summon Premiere Elements 2023 to edit video. You can purchase Photoshop Elements 2023 and Premiere Elements 2023 as stand-alone apps for $145.19 each but buying them in a bundle is cheaper at $219.99

Photoshop Elements 2023 can also work with high-quality Raw files, including digital negative (DNG) files created by devices such as the iPhone 14 Pro. These files open in a separate plug-in workspace – Camera Raw 14.4.0 – which you can download from the Help menu's Updates section.

This powerful digital darkroom places the most useful photo-fixing tools close to hand, enabling you to selectively boost weaker colours and lighten under-exposed shadows for example. As you'd expect, Element's Camera Raw editor lacks some of the more advanced tools found in the full version of Photoshop, such as the ability to make selective adjustments using gradient and brush-based tools for example. However it will still enable you to produce high-quality results compared to editing compressed JPEG files in the Quick, Guided or Expert workspaces. If you want to try it out, a 30-day trial version of Photoshop Elements 2023 is available.

> "Photoshop Elements 2023's one-off purchase price should make it an attractive alternative to Photoshop CC's rolling monthly subscription costs."

Photoshop Elements 2023 provides all the tools that a photographer requires, plus it guides you through a host of creative edits.

George Cairns

★★★☆☆

COVER FEATURE

Don't get tracked online in 2023

Tech companies are using ever more devious methods to collect your data. ***Robert Irvine*** *explains what you must do now to stay completely private online for the whole of next year.*

WHAT YOU CAN DO

- Prevent companies from targeting you with adverts
- Stop websites using 'fingerprinting' to identify you
- Block all hidden trackers embedded in emails
- Bypass cookie-consent pop-ups automatically
- Stop Google breaking your tracker-blocking extension
- Block trackers that collect your data in mobile apps
- Avoid online surveillance by encrypting your connection

It would be nice to think that 2023 will be the year that tech companies finally start respecting our private data, but – spoiler alert – that's not going to happen.

Old tracking habits die hard, and in the last few months alone we've seen Google settle a $392 million lawsuit for tracking its users' locations, Apple accused of collecting data through built-in iOS apps, and TikTok forced to deny that it's tracking US citizens using GPS. Even the privacy-focused DuckDuckGo was found to allow Microsoft trackers in its mobile browser, though these have since been blocked.

The good news is that, by necessity, there are now plenty of tools that reduce the amount of data companies can gather and share about you as you browse the web on your PC and use apps on your phone and tablet. However, the biggest problem remains that there are so many types of tracking there's no single solution to help you stay anonymous online.

Here we explain your options for guaranteeing your privacy over the next 12 months, and why it's essential to make these changes now before the risks become more severe, and your data falls into even more companies' hands. We'll expose the most serious tracking threats and reveal how to beat them in 2023.

WHY YOU MUST BLOCK ONLINE TRACKERS NOW

I already block third-party cookies – won't that stop tracking?

Although blocking third-party cookies in your browser helps prevent companies from following you around the web, it's no longer enough to stop your data being collected, shared and used to build a profile of things you're interested in. In fact, tracking companies now rely less on the traditional method of using cookies to target you with ads based on your perceived interests.

What, even Google?

Especially Google, which plans to phase out third-party cookies in its Chrome browser by late 2024. It has been conducting trials of new tracking systems as part of its Privacy Sandbox initiative – the first one, called FLoC (Federated Learning of Cohorts) was abandoned at the start of the year, following concerns from other browser developers and privacy groups. It was replaced by Topics, which shows you adverts based on the types of websites you visit. Google believes that Topics offers greater privacy than cookies, because it groups you with other Chrome users who have similar interests, rather than using unique identifiers. However, by scrapping cookies in Chrome in favour of its own system, Google may actually gain more control of your data.

What about other companies that track us?

Web giants including Amazon and Facebook are now shifting to 'first-party' tracking, which means they're focusing more on your activities across their own websites and apps, rather than following you around the web. They're then selling this data to advertisers who can target you accordingly on Amazon and Facebook services.

Even Apple, which has been praised for introducing tighter privacy controls, still allows tracking within its own products. Recently, it started showing ads for apps "you might also like" in the Apple App Store.

So tracking is still about showing us ads?

Only partly. As we explain in this feature, there are now many different ways for companies and criminals to track you, and a multitude of reasons for them doing so. These include secret methods for uniquely identifying you, gathering your personal information and spying on the sites you visit online as well as the places you go offline.

But hasn't this been happening for ages?

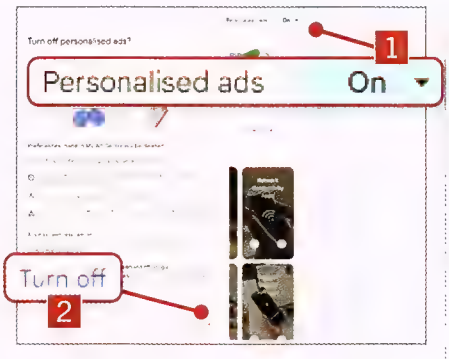
Yes, but tracking techniques are constantly becoming more sophisticated and devious, to circumvent the anti-tracking features now offered by privacy tools. They're set to gather more of our data than ever in 2023, which is why it's essential to address them now. Here are the 10 current biggest threats to your privacy and how to stop or at least limit their tracking.

1 Targeted advertising

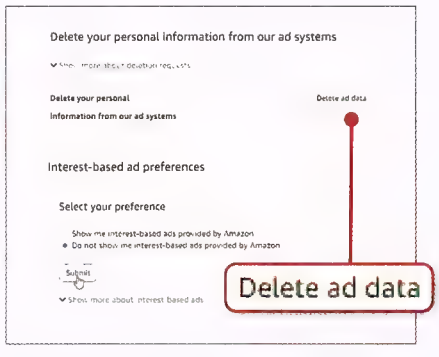
Adverts are an inescapable part of our online lives, but targeted ads are the most unnerving. When you search for or look at something on Google or Amazon, ads for related products and services often follow you around the web for days and weeks afterwards, and even across different devices. In the run-up to Christmas, when you're looking for gifts for other people, these ads may not even reflect your own interests. However, they still confirm that your activities are being tracked using cookies and hidden code embedded in sites and apps.

Because companies make more money by showing you ads for things you're likely to buy, targeted advertising is here to stay, and will be even more prevalent in 2023. Twitter's new owner Elon Musk has told Twitter advertisers that ads must be as "relevant as possible" and that "highly relevant ads are actually content!" whereas "low relevancy ads are spam".

So we're pleased that one effective new way to stop targeted advertising comes from the unlikely source of Google. The search giant has launched a tool called My Ad Centre (**www.snipca.com/44042**), which lets you turn off personalised advertising across Google Search, YouTube and Discover (the news feed in the Google and Chrome mobile apps), and "sites and apps that partner with Google". Simply click the button



Google's new My Ad Centre tool lets you switch off invasive personalised adverts.


Delete your personal information from our ad systems
Delete your personal
Information from our ad systems
Delete ad data
Interest-based ad preferences
Select your preference
Show me interest-based ads provided by Amazon
Do not show me interest-based ads provided by Amazon
Submit
Delete ad data

Stop Amazon showing you interest-based ads and delete ad data it's collected.

next to 'Personalised ads' (1 in our screenshot above) and select 'Turn off' 2. This won't affect the relevance of your search results.

Alternatively, you can leave the option switched on and customise the ads you see by selecting the topics and brands you're interested in. This doesn't mean Google has seen the error of its ways about tracking users – as we'll explain later – but it's a step in the right direction.

To turn off targeted Facebook ads, go to your 'Ad settings' page (**www.snipca.com/44044**), click 'Data about your activity from our partners' and switch off the option 'Use data from our partners'. Then click 'Ads shown off Facebook' and change the setting to 'Not allowed'.

Depersonalising ads from Amazon, which is now the third largest advertising network, is actually very easy. Just go to **www.amazon.com.au/adprefs**, select 'Do not show me interest-based ads provided by Amazon' then click Submit. You can also delete ad data Amazon has already collected about you (see screenshot above).

Microsoft targets you with ads for its own products and those of its partners, based on your web and Windows activities. To stop this privacy invasion, log in at **www.snipca.com/44045** and switch off the option 'See ads that interest you'.

Prevent targeted advertising from other companies by ticking their 'opt-out' boxes in the Digital Advertising Alliance's WebChoices tool (**www.snipca.com/44047**).

2 Browser fingerprinting

Browser fingerprinting is currently one of the most dangerous types of tracking because it's accurate, hard to spot and some browsers do almost nothing to keep you safe. Whereas most online tracking identifies you by implanting cookies or detecting your IP address, fingerprinting uses a unique combination of information about your device, including details of your browser, operating system, hardware specifications, installed software and extensions, internet provider, screen resolution, location, time zone and more.

Running a VPN won't disguise all this data and your browser's private mode does virtually nothing. It's estimated that around a quarter of the world's 10,000 most popular sites now use fingerprinting to track their users (**www.snipca.com/44055**).

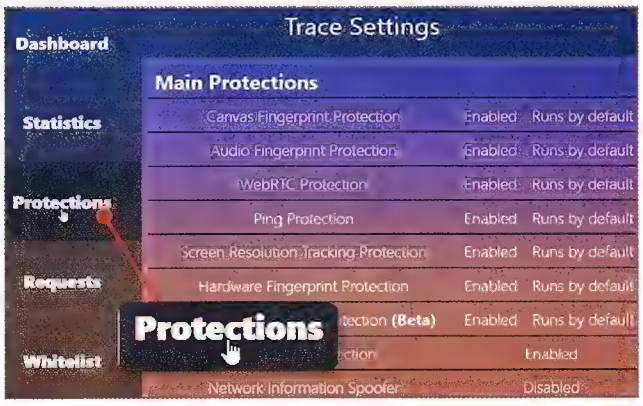
To check if your browser can be 'fingerprinted', visit Cover Your Tracks (**www.snipca.com/44050**) and click Test Your Browser – select 'Test with a real tracking company' for a thorough check. Within a few seconds, the site will tell you if your browser has a unique fingerprint (see screenshot below) and how many bits of identifying information you're leaking – scroll down to the Detailed Results section to learn what they are.

Preventing browser fingerprinting entirely is difficult, because the technology uses so many types of data about your system to create a unique ID, but there are ways you can reduce the risk.

Switch to Firefox, for example, and you'll benefit from Enhanced Tracking Protection, which stops known fingerprinting techniques identifying your device. It's available in all three privacy modes – Standard, Strict and Custom – which you can activate in the 'Privacy & Security' section of the browser's Settings.

Brave browser has even more sophisticated tools and its Shields feature can block canvas, WebGL and many other fingerprinting types (see **www.snipca.com/44052**).

With Chrome and Edge, you can install the powerful privacy extension Trace (**www.snipca.com/44054**), which blocks various types of fingerprinting (canvas, WebGL, audio and hardware) as well as other threats including ad servers, tracking scripts and malicious domains. We recommend using its Standard or High level of protection, because the Extreme option can stop sites working properly. To enable or disable its anti-fingerprinting settings, go to Settings, click Configure and choose Protections (see screenshot above).



Privacy tool Trace blocks several types of fingerprinting in your browser.

> "Browser fingerprinting is currently one of the most dangerous types of tracking because it's accurate, hard to spot and some browsers do almost nothing to keep you safe."

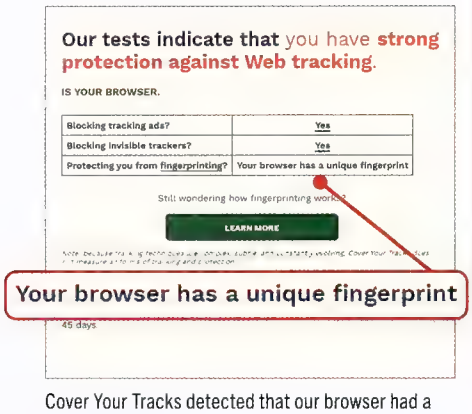
3 Spell-jacking

Ensuring that your spelling is correct in forms you fill in online doesn't sound like a risky activity, but you could be sending personal data straight to Google and Microsoft. That's according to a report earlier this year by cyber-security company Otto, which found that the enhanced spell-check features in Chrome and Edge share form information with their parent companies (**www.snipca.com/44067**). This includes users' names, home addresses, email addresses, dates of birth, payment details and more. What's more, if you enable the 'Show password' option for a login box, it will also send your password to Google or Microsoft.

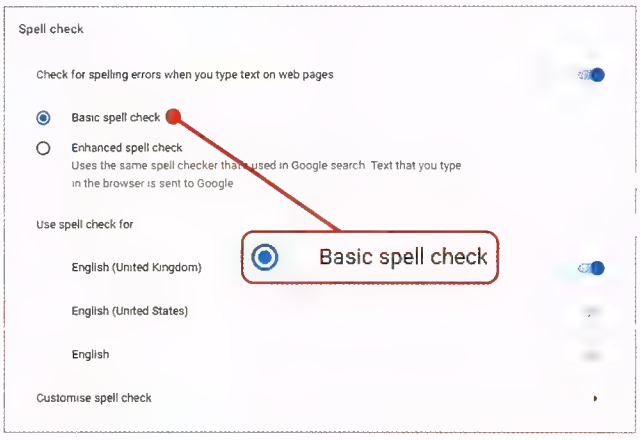
Otto calls this privacy threat 'spell-jacking' and found that it exposed sensitive data on more than 50 sites, including online banking, shopping and social media. Thankfully, you can easily turn off these enhanced spell-checking features to stop your personal information being tracked.

In Chrome, click the three-line menu button, choose Settings and select Languages. In the 'Spell check' section, either disable 'Check for spelling errors when you type text on web pages' or switch from 'Enhanced spell check' to 'Basic spell check' (see screenshot below) to stop your data being shared with Google.

In Edge, go to Settings then Languages and turn off 'Use writing assistant' or choose Basic spell-checking instead of using Microsoft Editor.


Our tests indicate that you have strong protection against Web tracking.
IS YOUR BROWSER.
Blocking tracking ads? Yes
Blocking invisible trackers? Yes
Protecting you from fingerprinting? Your browser has a unique fingerprint
LEARN MORE
Your browser has a unique fingerprint
45 days

Cover Your Tracks detected that our browser had a unique fingerprint.


Spell check
Check for spelling errors when you type text on web pages
Basic spell check
Enhanced spell check
Uses the same spell checker that is used in Google search Text that you type in the browser is sent to Google
Use spell check for
English (United Kingdom)
English (United States)
English
Customise spell check
Basic spell check

Switch from 'Enhanced spell check' to 'Basic spell check' to stop Chrome sharing your data with Google.

4 Email tracking

Many companies embed hidden trackers in the emails they send you, which allows them to see when and where you opened the message, and the device you used.

Last year, the BBC reported that two-thirds of emails contained 'spy pixels' that collect this data, even after excluding spam (**www.snipca.com/44091**). Companies use this information to build a profile of you, so they can target you with further marketing messages and 'relevant' ads, not just in your inbox but across websites and apps as well.

Although email tracking is becoming a bigger problem, methods of blocking it are improving. In August 2022, DuckDuckGo launched its Email Protection service, which removes multiple types of hidden email trackers, including pixels and links (**www.snipca.com/44092**).

Email Protection gives you a '@.duck.com' email address you can use when signing up with websites, which forwards messages to your usual inbox after removing all the trackers. It's free to use and is available in the DuckDuckGo extension for Chromium browsers and Firefox (**www.snipca.com/44093**), and DuckDuckGo Privacy Browser for Android (**www.snipca.com/44083**) and iOS (**www.snipca.com/44094**).

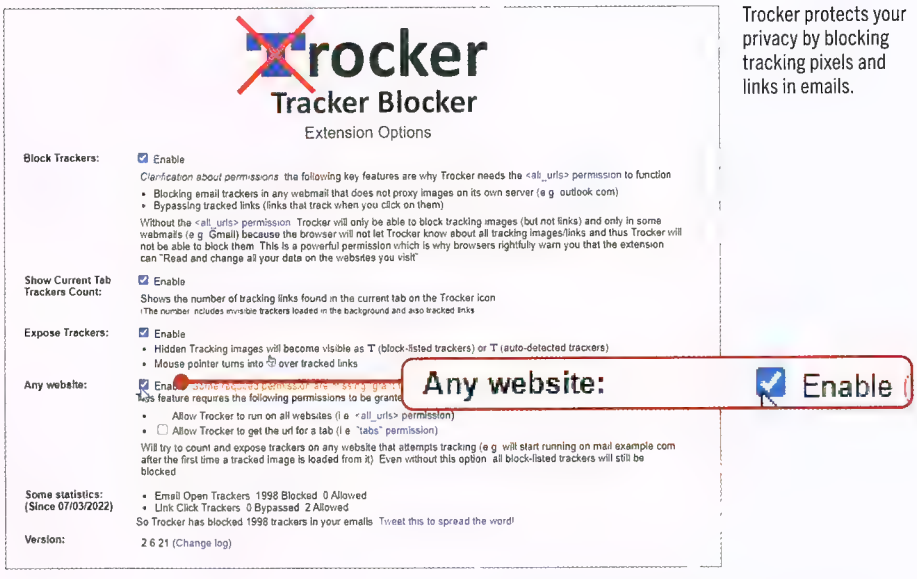
Alternatively, you can install Trocker for Chromium browsers (**www.snipca.com/41171**) or Firefox (**www.snipca.com/41172**), which saves you needing to use a forwarding service. This extension prevents invisible tracking pixels in emails from loading, while still allowing normal images and graphics to display.

Trocker works in Gmail, Outlook and Yahoo Mail, but make sure you enable its 'Any website' setting (see screenshot above right) so it can also block tracking links in messages. This allows you to visit the relevant web pages without revealing you've clicked their links.

5 Confusing cookies

The cookie-consent boxes that appear when you visit websites can be both annoying and confusing – should you simply click Accept All or go through the hassle of tweaking individual privacy settings?

Fortunately, there are a couple of reliable ways to stop cookies tracking you without clicking anything. The first is to install Consent-o-Matic in your Chromium (**www.snipca.com/43417**) or Firefox (**www.snipca.com/43418**) browser. This answers cookie-consent prompts for you, either by rejecting all cookies or – as with the Government's proposal – specifying which cookies you're happy to accept.



Trocker protects your privacy by blocking tracking pixels and links in emails.

Your second option is to use Brave browser, which was recently updated to block cookie pop-ups automatically and stop you being tracked. Brave will offer to hide these banners when you install it or let you switch on the setting manually. Click Brave's three-line menu button and choose Settings, then Shields. Select 'Content filtering' and tick the box next to 'Easylist – Cookie List' (see screenshot below).

6 Manifest V3

Many of us use content-blocking extensions to protect our privacy online by filtering ads, trackers and other spying software from web pages. Popular examples include uBlock Origin, Privacy Badger and Ghostery. But in 2023, many of these tools could stop working – or at least stop working as effectively – because of Google's new extensions system Manifest V3 (**www.snipca.com/44058**).

Manifest V3 is designed to make add-ons more secure by more tightly controlling their permissions and where they store code and data. It officially began rolling out in January and by June 2023 you will no longer be able to install extensions that use the previous system, (V2), from the Chrome Web Store.

Brave blocks all cookie-consent pop-ups to prevent websites from tracking you.

The main problem is that Manifest V3 changes the way that add-ons block content. Instead of being able to block entire categories of unwanted web requests, they'll now be limited to targeting a blocklist of specific URLs. They'll also be restricted to running 30,000 filtering 'rules' – currently, most content blockers use at least 300,000 rules. This means you're likely to see more ads and have your data collected by more trackers, which may partly be Google's intention.

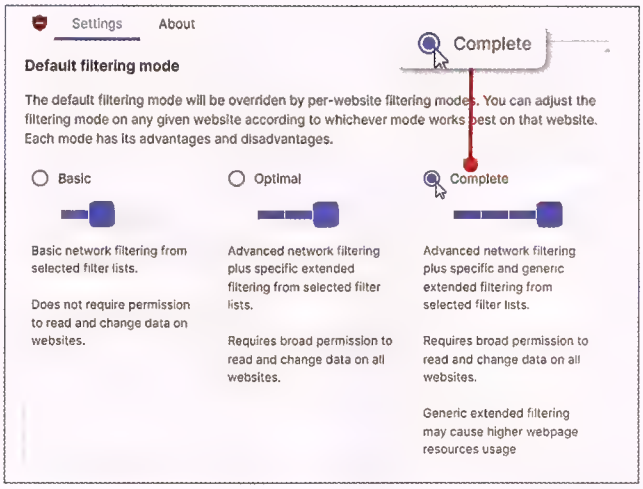
Some developers have already created Manifest V3 versions of their blocking tools, including uBlock Origin Lite (**www.snipca.com/43521**) and AdGuard AdBlocker MV3 (**www.snipca.com/43206**), which you can install now to test their efficiency. In the former, you should enable the Complete filtering mode for optimum protection against trackers (see screenshot below), but even this isn't as reliable as the full version of uBlock Origin (**www.snipca.com/44063**).

Brave and Vivaldi, which have built-in ad and tracker blockers, insist that they won't be affected by Manifest V3, while Mozilla says that Firefox 109 will support extensions that use the new system when it's released in January, but will maintain the old way of blocking content.

It's possible that Google will delay the roll-out of Manifest V3 to give developers more time to update their add-ons, but Chrome and Edge users who want to enjoy a tracker-free internet may soon need to reconsider their choice of browser.

7 Trackers in mobile apps

There have been lots of news stories this year – and you can expect more in 2023 – about dangerous apps in the Google Play Store that infect your device with malware, steal your data


Settings
About
Complete
Default filtering mode
The default filtering mode will be overriden by per-website filtering modes. You can adjust the filtering mode on any given website according to whichever mode works best on that website. Each mode has its advantages and disadvantages.
Basic
Optimal
Complete
Basic network filtering from selected filter lists.
Does not require permission to read and change data on websites.
Advanced network filtering plus specific extended filtering from selected filter lists.
Requires broad permission to read and change data on all websites.
Advanced network filtering plus specific and generic extended filtering from selected filter lists.
Requires broad permission to read and change data on all websites.
Generic extended filtering may cause higher webpage resources usage

The Complete filtering mode in uBlock Origin Lite will block the most trackers on websites.

and display annoying ads. However, many supposedly respectable mobile apps also threaten your privacy by using trackers to collect and share information about your activities.

Apple now combats this threat using a feature called App Tracking Transparency, which is enabled by default. Open the Settings app on your iPhone or iPad and select Privacy (or 'Privacy & Security'), then Tracking. If 'Allow Apps to Request to Track' is set to On, apps will request your permission to track you. If it's switched off, they'll be denied this permission automatically.

Both the Apple App Store and Google Play Store now include privacy labels that tell you which information apps collect about you and whether it's linked to your identity. You can also check app permissions on your phone or tablet. In iOS (15.2 or later), go to Settings then Privacy, tap App Privacy Report and select Turn On App Privacy Report.

This feature tells you which apps are accessing specific data and sensors on your iPhone or iPad, including your location, camera, microphone, contacts and photos. It also reveals which advertising networks and other domains apps are connecting to in the background. Although you can't revoke permissions directly from App Privacy Report, you can adjust them via the Privacy screen, or uninstall apps if their behaviour concerns you.

Android 12 introduced a similar feature called 'Privacy dashboard', which tells you which apps are using which permissions and when they are doing so. To access it, open Settings and select Privacy followed by 'Privacy dashboard'. Browse the list of permissions such as Location, 'Call logs' and Contacts' to check for anything suspicious.

To view this information on older versions of Android, choose Apps (or 'Apps & notifications') in Settings, tap Advanced and select 'Permission manager' (or 'App permissions').

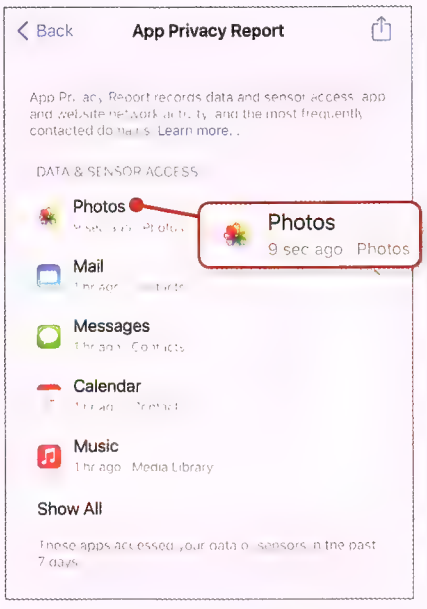
However, permissions don't tell the whole story – especially on Android devices – and hidden trackers in apps may be secretly sharing your data. Enter the name of the URL of a Google Play Store app into privacy-audit site Exodus (**www.snipca.com/44082**) to see all the embedded trackers it contains – even trustworthy apps could contain several.

Disabling trackers is difficult, but you can at least prevent them from building a profile of your interests to target you with ads. On an Android phone or tablet, go to Settings and select Privacy, then Ads. Tap 'Reset advertising ID' and choose either Confirm or 'Opt out of Ads Personalisation' (depending on your Android version). Also tap the option to

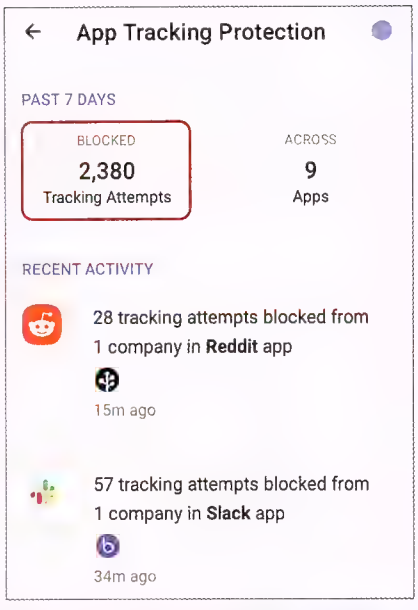
'Delete advertising ID'. In iOS, open Settings and tap Privacy, then Advertising. Enable the Limit Ad Tracking option and tap Reset Advertising Identifier.

The best way to block app trackers on your Android device is to install the aforementioned DuckDuckGo Privacy Browser. This includes a feature called App Tracking Protection, which stops hidden trackers in all your installed apps collecting your data, while still allowing necessary permissions.

To activate it, tap the three-dot menu in the browser, choose Settings, then enable App Tracking Protection. Tap 'OK' to allow DuckDuckGo to set up a VPN on your device. This isn't a real VPN but will allow it to block trackers at a network level. The browser will tell you how many tracking attempts it's blocked in apps in the last seven days (see screenshot above right) as well as the tracking companies responsible.



The App Privacy Report in iOS tells you which apps are accessing your data.



DuckDuckGo's Android browser automatically blocks tracking attempts in apps.

8 Tracking devices

In theory, Apple AirTags sound like a great idea – attach one to your keys, bag, wallet or other valuables, and you can locate the item using the Find My function on your iPhone or iPad if it's lost or stolen. The whole process is anonymous and encrypted so only you can see the current position of the AirTag – what could possibly go wrong? Sadly, over the last year, AirTags have been exploited by thieves and stalkers to track people – a device is hidden in someone's belongings or on their person to relay their whereabouts to the spy. AirTags have even been attached to vehicles to track them for later theft.

To mitigate privacy concerns, Apple updated its iOS software to alert you when an unknown AirTag appears to be moving with you or has been separated from its owner for a few hours. You'll see an Unknown Accessory Detected message and the tracking device will start beeping after 24 hours. However, you first need to ensure alerts are active: open the Find My app on your iPhone or iPad, tap the Me icon in the bottom-right corner and switch on Item Safety Alerts.

If you have an Android device, install the free app AirGuard (**www.snipca.com/44086**). This uses Bluetooth to scan your surroundings for potential tracking devices such as AirTags, tells you when and where you've been tracked, and lets you identify the mystery device by making it play a sound (see screenshot above).

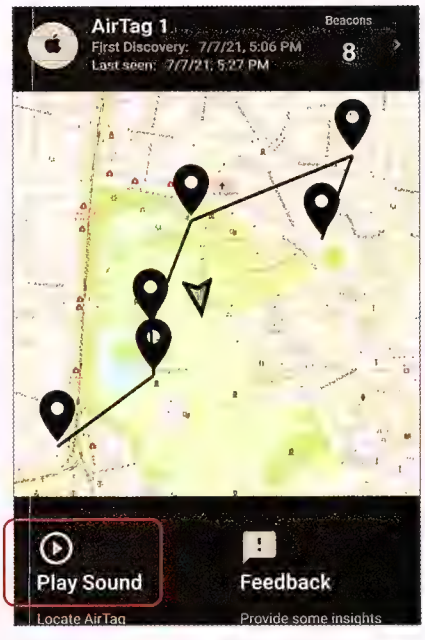
9 Spying search engines

It's no secret that Google and Bing use data they collect about our search queries to filter our search results, build a profile of our interests and target us with relevant ads from their 'search partners'. But most of us still stick with Google – and to a lesser extent Bing – as our main search engine, because it's the default option in our browser or on our mobile device, and because its results are reliable and fast. If you want to stop your searches being tracked in 2023, it's essential to switch to a privacy-focused search engine, so we're pleased that there's now more choice than ever.

> "The best way to block app trackers on your Android device is to install the aforementioned DuckDuckGo Privacy Browser."

The most popular, private alternative to Google is DuckDuckGo (**https://duckduckgo.com**), which doesn't collect or share details of your searches, or use personal data to identify you. DuckDuckGo is now a search-engine choice in all the main browsers and its results mainly come from Bing but without any tracking. To remove the (non-targeted) ads that appear above results, click the menu button in the top-right corner, choose All Settings and switch off Advertisements.

Startpage (**www.startpage.com**) is another good choice, giving you the benefit of Google results, but without storing your searches, implanting tracking cookies in your browser or sharing your data with third parties. You can further boost your privacy using its Anonymous View, which opens web pages through a proxy server – click the mask icon next to a search result to use this feature.



AirGuard reveals if a hidden AirTag is being used to track your location.

We also like the tracker-free Brave Search (**https://search.brave.com**), which uses its own independent search index, as well as results from other search engines when necessary. Brave will soon add adverts to its search results, but these won't be based on your personal activity.

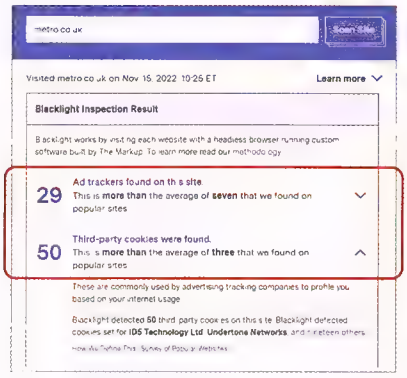
In 2022 a new private search engine called Neeva (**https://neeva.com**) launched. This doesn't include any adverts or track your personal information. Neeva promises to protect you from web trackers and uses results from Bing, Apple and Yelp. You're encouraged to sign up for a free account

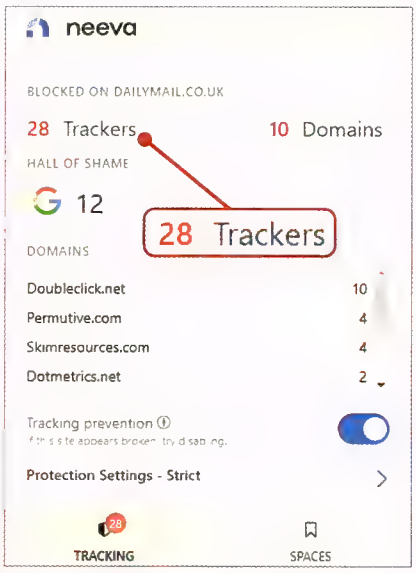
EXPOSE HIDDEN TRACKERS IN WEBSITES

The best content-blocking extensions, including Privacy Badger (**www.snipca.com/44105**) and uBlock Origin, list domains that try to track you, but it's also useful to have this information upfront.

To expose all the hidden trackers in a website before you visit, enter its web address in the free online tool Blacklight (**www.snipca.com/44106**) and click Scan Site. The 'real-time privacy inspector' will then check the site for tracking tech, including ad trackers, third-party cookies, keystroke capturing, Facebook pixels and (less worryingly) analytics tools. For example, it found the Metro newspaper's website contained 29 ad trackers and 50 third-party cookies (see screenshot).

To view hidden trackers as you browse the web, install Thunderbeam-Lightbeam (**www.snipca.com/44107**) in your Chromium browser. This extension visualises trackers by using circles to represent the sites you visit and triangles to show the third-party servers connected to each site, which may be tracking your data.


metro.co.uk
Scan Site
Visited metro.co.uk on Nov 15, 2022 10:26 ET
Learn more
Blacklight Inspection Result
29
Ad trackers found on this site
This is more than the average of seven that we found on popular sites
50
Third-party cookies were found.
This is more than the average of three that we found on popular sites
These are commonly used by advertising tracking companies to profile you based on your internet usage
Blacklight detected 50 third party cookies on this site. Blacklight detected cookies set for IDS Technology Ltd, Undertone Networks, and fifteen others.



Neeva lets you search the web privately and blocks trackers on websites.

to improve your search results, but this only requires your email address.

Install the Neeva Search + Protect extension (**www.snipca.com/44100**) to set Neeva as your default search engine in your Chromium browser or Firefox, and block trackers automatically (see screenshot above right). There's also a free 'Neeva Browser & Search Engine' app for Android (**www.snipca.com/44101**) and iOS (**www.snipca.com/44102**).

10 Government surveillance

One way to stop your ISP and government agencies seeing where you go online is to make sure a feature called DNS-over-HTTPS is switched on in your web browser. This encrypts the DNS requests your browser makes when you enter web addresses, making it more difficult (but not impossible) for your ISP to identify the sites you visit.

In Chrome or Brave, go to Settings, click 'Privacy and security' and choose Security. Make sure 'Use secure DNS' is switched on and select either 'With your current service provider' or an alternative DNS server such as Cloudflare.

In Edge, go to Settings, then 'Privacy, search and services', scroll down to Security and ensure the 'Use secure DNS...' option is enabled. In Firefox, go to Settings, then General and scroll down to Network Settings. Click the Settings button and tick 'Enable DNS over HTTPS'.

A more effective way to avoid tracking is to browse the web through a VPN. Although VPNs are most commonly used to disguise your location, so you can access online content that's blocked in your region, they also encrypt your internet connection so nobody can see what you're doing – including your ISP.

The downside is that the best VPNs require a paid-for subscription while some free services collect and share your data. They may also be subject to Fourteen Eyes surveillance (see **www.snipca.com/43712**).

The best free way to stay completely anonymous online is to use Tor, which redirects your internet connection through a series of 'relays' across the world. This encrypted 'circuit' prevents websites, internet providers, government agencies, hackers and other spies from seeing your real IP address and location, and stops them tracking you. Unlike a VPN, there's no central service you need to trust to browse privately, and no risk of your activities being logged and your details being passed to third parties.

The most common way to access Tor is through Tor Browser (**www.snipca.com/44089**), which is based on Firefox and is available for Windows, Linux, macOS and Android. This works in permanent private-browsing mode, which means that cookies, site data and your browsing history are always deleted when you close it, leaving no trace of what you've been doing.

However, Tor can be very slow, lacks essential browser features such as extensions and – by blocking scripts and other page elements – makes some sites frustrating or even impossible to use. One alternative is to use the Tor function built into Brave, which conceals your browsing activities and your IP address, without sacrificing speed. Press Alt-Shift-N to open a private Tor window or click the menu button and choose 'New private window with Tor'. An even better option is to use OnionFruit (**www.snipca.com/43513**). This free tool connects your current browser to the Tor network at the click of a button, encrypting your data and preventing your ISP and the Government from seeing what you're doing. Unlike Tor Browser, it also lets you choose which country you appear to be browsing from. Click 'More info' then 'Run anyway' if you get a SmartScreen warning when installing the program – it's completely safe to use. ■

HOW YOUR EYES CAN NOW BE TRACKED BY ADS

Meta – which owns Facebook, Instagram and WhatsApp – is always looking for new advertising opportunities, but its latest method of tracking users is literally eye-opening. The company's new virtual-reality headset, the Meta Quest Pro (**www.snipca.com/44109**), includes interior cameras that let it track your eye movements and facial expressions.

Although the feature is intended to make your avatar behave realistically in the metaverse, it's also a major privacy concern because the eye-tracking data will be shared with third-party apps and used to "personalise your experiences" (**www.snipca.com/44108**). Meta will be able to gauge your reactions to ads you see in the metaverse by monitoring your eyes and face, and target you with further ads that are so relevant you might not even realise they're ads. In fairness, the face-tracking option in the Meta Quest Pro will initially be disabled by default, and nobody can force you to wear a $1,500 VR headset. But it's a worrying indication of how tracking techniques are evolving and becoming more intimate.

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BEST FREE DOWNLOADS FOR 2023

Prepare your PC, phone and tablet for 2023, without paying a cent. Robert Irvine reveals all the best free software, apps and downloads to get you through the year ahead.

WHAT YOU CAN DO

- Remove hidden PC junk using Microsoft's new clean-up tool
- Back up files and drives without paying for premium options
- Try Thunderbird's new Android app before anyone else
- Legally download thousands of classic books for free
- Download high-quality films to watch over the next year
- Save old radio shows to your PC or phone to play offline
- Download free music from YouTube to use however you want

After a stressful year in which almost everything has become more expensive, most of us will be watching our finances carefully in 2023. When you're struggling to pay for energy, food and other household bills, spending even a few pounds on a program, mobile app or book can seem an extravagant and unnecessary luxury, even though in the past you may have splashed out without a second thought.

There's always been plenty of free software that will save you money – we feature it in our Windows Software section every issue. However, even this is becoming more scarce, as developers increasingly limit useful options to paid-for versions or move towards scrapping their free programs altogether.

However, it's not all doom and gloom, and there is still lots of great stuff you can get for free, provided you know where to look. Here, we recommend the best software and apps you should download in 2023, both to replace popular tools that will disappear over the next 12 months and to try exciting new features before everyone else. We also reveal where to find other fantastic freebies, including ebooks, audiobooks, films, games and much more.

All 20 of our recommendations in this issue will have special relevance and usefulness in 2023, and will hopefully make the next year cheaper and easier than the last.

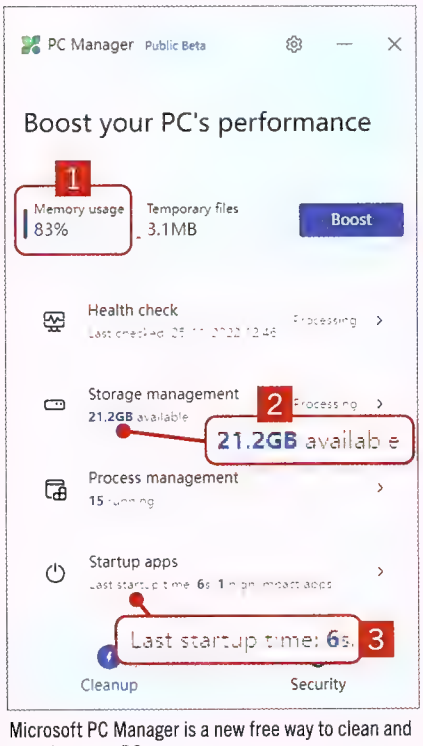
5 NEW FREE PROGRAMS YOU MUST DOWNLOAD

1 Microsoft PC Manager

Microsoft caused a stir in October when it quietly released a new PC clean-up tool called PC Manager through a Chinese website. The free app has since been added to the Microsoft Store (though its page is currently hidden) and now has an English-language website (**www.snipca.com/44240**), and we expect it to be officially launched in the first half of 2023.

Although PC Manager is still at the 'public beta' stage, it already provides a fast and effective way to clean and speed up your computer. You can remove junk files and space hogs; disable unwanted startup items and background processes; and scan your PC for threats and driver updates.

The app is very easy to use and integrates seamlessly with Windows 10 and 11 to perform clean-up tasks with a single click and reveal useful information about your system. This includes your current memory usage (1 in our screenshot below left), how much storage you have available 2 and how long your PC takes to start 3.



Microsoft PC Manager is a new free way to clean and speed up your PC.

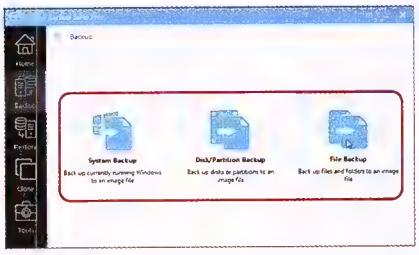
PC Cleaner is worth downloading now to try a simpler, if less sophisticated, alternative to CCleaner and BleachBit. You may experience a few bugs, but Microsoft is regularly updating the app to fix reported problems.

When we tested it, we noted that 'treats' were found and there was a nagging suggestion to change our browser to Edge. In the latest beta version, this has been corrected to 'threats' and PC Cleaner now respects and protects your default browser. We can't wait to see its first stable release in 2023. Be aware that some Windows users have experienced problems when trying to install PC Manager – see our box below for potential fixes.

2 Hasleo Backup Suite 3

In sad news for users of Macrium Reflect Free – and we know that includes many *APC* readers – the excellent free backup program is being retired. Although you'll still be able to use the current version of the software (Reflect 8 Free), it will no longer be updated and won't receive security fixes after 1 January 2024. This puts your backups at risk from vulnerabilities that could allow hackers to steal your files.

It also means it's wise, if not essential, to find an alternative backup solution in 2023. You may be familiar with Paragon's 'Backup & Recovery' Free Edition (**www.snipca.com/44247**) and AOMEI Backupper Standard (**www.snipca.com/44248**), which are free versions of paid-for backup software with some features missing, but a new option to consider is Hasleo Backup Suite (**www.snipca.com/44245**).



Hasleo Backup Suite lets you back up your system, hard drives and specific files.

Free to use – with no options locked behind Upgrade buttons – version 3 (released in November) provides everything you need to back up your hard drives, partitions and entire system, and now also lets you back up specific files and folders.

Hasleo Backup Suite 3 is a doddle to use – simply click New Backup on its home screen, choose System, Disk/Partition or File Backup (see screenshot above), then select the relevant item(s) and backup destination, and click Proceed.

You can secure your backups by encrypting them, compress files to save space and choose between full, incremental and differential backups. The software also lets you schedule your backups to run at the frequency and time of your choice, as well as offering a Clone tool for copying your current Windows installation to another PC.

3 Paint.NET 5

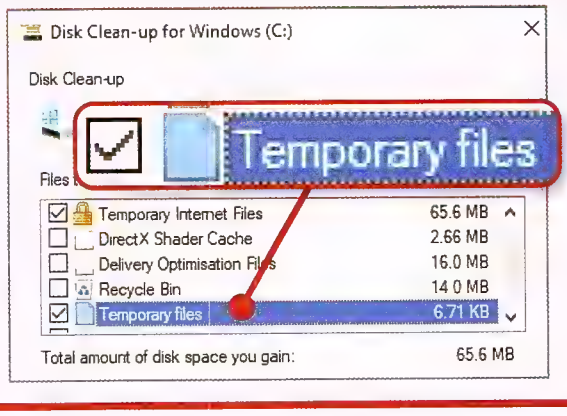
Packed with powerful tools and useful effects, Paint.NET has long been one of our favourite free image editors. But although it's been updated many times over the years, the last major version (Paint.NET 4.0) was released in 2014, and rival programs such as GIMP and PhotoDemon have lured users away. So we're excited that 2023 will see the arrival of Paint.NET 5, which is optimised for modern computers and current ways of working with graphics.

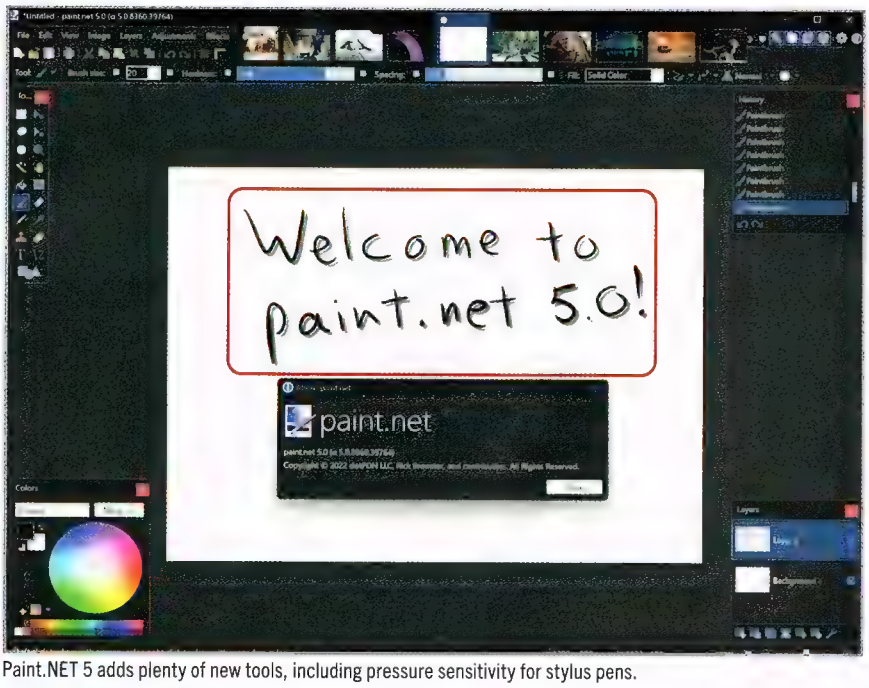
WHAT TO DO IF PC MANAGER WON'T INSTALL

If you experience problems installing Microsoft PC Manager, try running the tool as administrator. Right-click the downloaded 'MSPCManagerSetup.exe' file, choose 'Run as administrator' and click Yes to allow the app to make changes to your device.

If that doesn't help, try deleting temporary files using Disk Clean-up, which is ironically the tool that PC Manager is designed to replace. Type disk into the Windows search box, click 'Disk Clean-up', select your hard drive and click OK. Tick the boxes for Downloaded Program Files, Temporary Internet Files and 'Temporary files' (see screenshot), then click OK to delete them.

It's also possible that your antivirus software is blocking PC Manager, because the tool is still in beta and is not recognised. Try disabling its protection temporarily, then restart your PC and run PC Manager again.


Disk Clean-up for Windows (C:)
Disk Clean-up
Files
Temporary files
Temporary Internet Files 65.6 MB
DirectX Shader Cache 2.66 MB
Delivery Optimisation Files 16.0 MB
Recycle Bin 14.0 MB
Temporary files 6.71 KB
Total amount of disk space you gain: 65.6 MB



Paint.NET 5 adds plenty of new tools, including pressure sensitivity for stylus pens.

In fact, if you don't mind a few bugs, you can download an 'alpha' preview version right now from www.snipca.com/44243 – click the 'paint.net.5.0.8361.33457.install.x64.zip' link.

Paint.NET 5 switches to using your PC's graphic processor to render images and perform most of its tasks. This makes it faster and more stable, improves picture quality and colour accuracy, and also boosts battery life on your laptop. There are new adjustments you can apply to your images, including Exposure, 'Highlights & Shadows' and 'Temperature & Tint', and new effects such as Straighten and Drop Shadow.

We're particularly looking forward to trying the new Bokeh effect, which lets you blur the background of photos while keeping the subject in focus. Previously, these options required you to install plug-ins.

Existing effects have been enhanced and Paint.NET has added 'pressure sensitivity' to let you write and draw with natural-looking brush strokes (see screenshot above right) using a stylus pen or graphics tablet.

Expect even more features in the final 2023 release.

4 ChromeOS Flex

After 10 January 2023, Microsoft will no longer provide security updates or technical support for Windows 7 or 8.1 (support for Windows 7 ended in January 2020, but extended security updates were still available).

This means that if you have an old laptop running either of those operating systems, it's no longer safe to use it to go online, because it will be vulnerable to malware. Microsoft has stopped offering free upgrades from Windows 7 or 8.1 to Windows 10 or 11, but you can give your laptop a new lease of life by downloading ChromeOS Flex.

This new operating system from Google effectively turns a Windows PC or Mac into a Chromebook, and works on most computers with at least 4GB of RAM, 16GB of storage and a 64bit processor. It gives you instant access to Google tools including Gmail, Drive and YouTube; it's simpler than Linux and more secure than Windows; and it's free.

To set up ChromeOS Flex, you first need to install a Chromium extension called Chromebook Recovery Utility (**www.snipca.com/42713**). This lets you create a bootable version of the operating system on an 8GB USB stick (see screenshot below left). You can follow Google's installation instructions at **www.snipca.com/44241**.

Once you've successfully booted ChromeOS Flex, you can permanently install it on your old laptop, which will wipe Windows and all your data, or continue running it from your USB stick. Choose the latter option first to ensure ChromeOS Flex connects to your home network and works properly, then – if you're happy with it – keep using it for the rest of 2023 and beyond. Check how long your device will be supported at **www.snipca.com/44242**.

5 Bitwarden Free

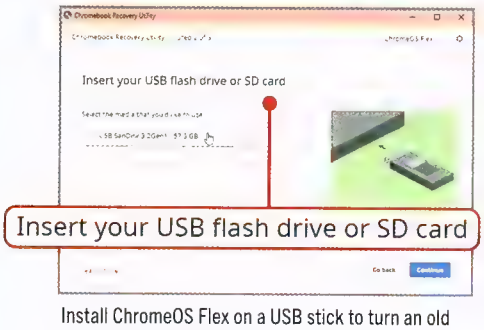
Five years after it launched, the free password manager RememBear – from the company behind the TunnelBear VPN – will be discontinued on 18 July 2023.

"By the time RememBear was released, many users had already found their password solution and switching to a new service was simply too much to ask," admitted the RememBear team in a blog post (**www.snipca.com/44249**). But if you are looking for a more secure and versatile way to manage your passwords than the password manager built into your browser, and don't like the restrictions imposed by LastPass on free accounts, Bitwarden Free (**www.snipca.com/44250**) is by far your best option.

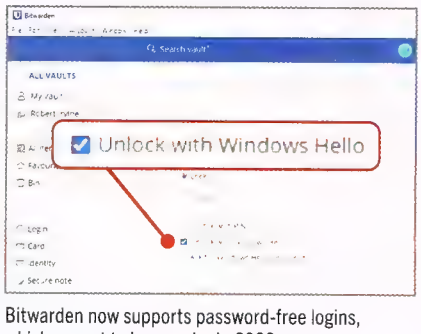
Bitwarden had an outstanding 2022, introducing such useful features as the ability to generate unique usernames and create email aliases using services including Firefox Relay and DuckDuckGo Email Protection.

It also added support for passwordless logins through Touch ID, Windows Hello and other biometric methods. These make securing your accounts much easier and are set to become more widely used in 2023, while Bitwarden is certain to continue its innovative streak.

Bitwarden's basic free plan gives you all the features you need to store and secure your passwords, payment-card details and identity information. You can sync your data across an unlimited number of devices using its desktop and mobile apps, browser extensions and web vault, and easily import details from other password managers, including your browser's.

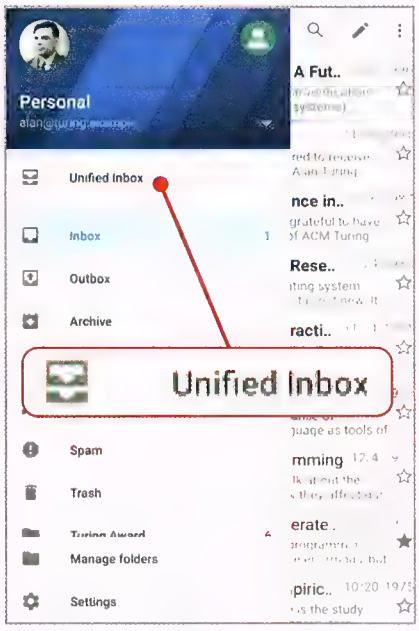


Install ChromeOS Flex on a USB stick to turn an old laptop into a Chromebook.



Bitwarden now supports password-free logins, which are set to be popular in 2023.

5 FREE APPS YOU MUST DOWNLOAD

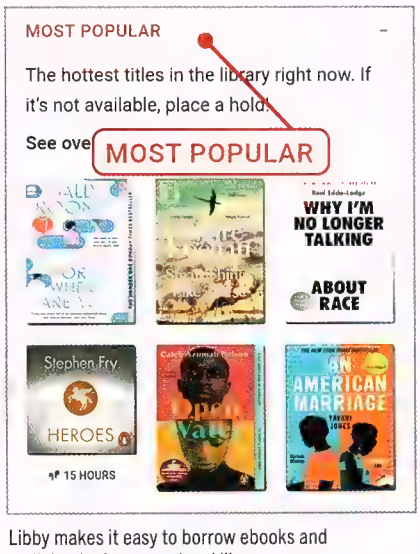


Thunderbird for Android will be based on K-9 Mail, which you can download now.

6 Thunderbird for Android

In our 'Stop using Gmail and Outlook' feature in Issue 516, we recommended Mozilla's Thunderbird as the best alternative way to access your emails from those services. The only problem is that Thunderbird doesn't have a mobile app, so you can't send and receive messages on your phone or tablet. Happily, Thunderbird has now confirmed that an Android app is in development (there's no word on an iOS version) and is likely to be released in mid-2023.

If you can't wait that long, you can preview it now by downloading K-9 Mail (**www.snipca.com/44251**), which will eventually evolve into Thunderbird for Android. The free app has an unified inbox (see screenshot left) for emails from all your accounts, supports OpenPGP end-to-end encryption and lets you read messages without being tracked



Libby makes it easy to borrow ebooks and audiobooks from your local library.

7 Amazon Photos

On 31 October 2022, Amazon removed its Drive app from the Google Play and Apple app stores, and on 31 December 2023 the online storage service will be permanently shut down. But if you only store photos and videos in Drive, you can use Amazon Photos instead – in fact, your files are probably synced with it already.

The free Amazon Photos app for Android (**www.snipca.com/44253**) and iOS (**www.snipca.com/44253**) was recently redesigned to improve its search filters and let you share pictures and videos privately (see screenshot below left). It backs up your photos automatically so you never lose them, and lets you use them as a screensaver on your Fire TV stick.

Prime members get unlimited photo storage and 5GB for videos, while non-Prime users get 5GB for both. There are also desktop apps for Windows and macOS.

8 Libby, by OverDrive

2023 will close the book on the OverDrive app, which lets you borrow ebooks and audiobooks from your local library to enjoy on your phone or tablet. It will soon be removed from the app stores and has been replaced by 'Libby, by OverDrive' for Android (**www.snipca.com/44254**) and iOS (**www.snipca.com/44255**).

Libby offers the same choice of titles in more than 40,000 libraries around the world, but has a more modern look, with lists of popular books (see screenshot above) and recommendations from librarians. Simply search for a library by name or location, then either sign in with your library card or request one. You can then browse available ebooks, audiobooks and magazines, and download them to the app for free. Libby alerts you when your loan period is about to expire so you can return titles and borrow more.

9 Mapillary

Google has made the surprising decision to scrap its popular Street View app in March 2023. You'll still be able to access Street View in Google Maps, but as that app is crowded with other features, many of us will miss the simple standalone version.

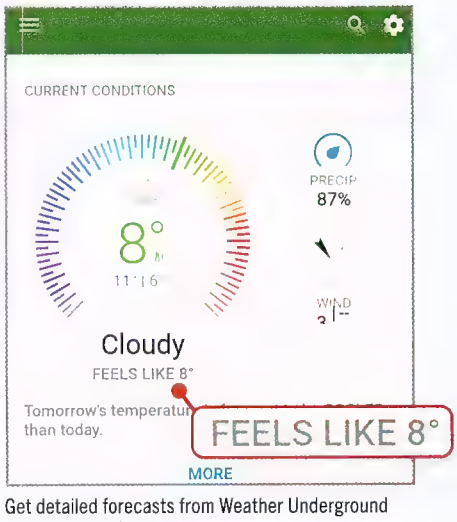
One alternative is to download Mapillary for Android (**www.snipca.com/44257**) and iOS (**www.snipca.com/44256**), which lets you both explore and capture street-level imagery. Sign up for a free account or use the app as a guest, then either search for a location or let Mapillary detect where you are. Press 'Explore' and tap the green lines and dots on the map to view photos taken by other users. Click 'Capture' to record and upload your own images.

Mapillary isn't as comprehensive as Street View, and its coverage of some areas of Australia is rather sparse. But its imagery is constantly improving and it was recently updated to fix performance problems – hopefully this will increase its poor rating on the Google Play Store.

10 Weather Underground

Two-and-half-years after it removed its Dark Sky weather app from the Google Play Store, Apple has now discontinued the iOS version too. Dark Sky's technology has been integrated with the Apple Weather app, but there are lots of other options for getting forecasts in 2023.

Weather Underground is our favourite, because it combines a Dark Sky-level of detail with a simple, attractive interface and it's free to download and use. Get accurate hourly and daily forecasts for the next 10 days, including chance of rain, wind speed and 'feels like' temperature (see screenshot above); set up severe weather alerts; view radar and satellite maps; and much more. The app is available for Android (**www.snipca.com/44258**) and iOS (**www.snipca.com/44259**).



Get detailed forecasts from Weather Underground now that Dark Sky has gone.

DOWNLOAD FREE ENTERTAINMENT, AUDIO, PHOTOS & GAMES

Global Grey offers thousands of classic books to download legally for free.

Download free audiobook versions of out-of-copyright titles from LibriVox.

11 Classic books that are now out of copyright

In most countries copyright law works on the principle of 'life plus 70 years', which means that books enter the public domain 70 years after the death of the author. However, in the US, works created before 1 January 1978 are protected for 95 years from the date they were copyrighted. This means that many classic books published in 1927 will enter the public domain in 2023 and you'll be able to download them as free ebooks from US websites such as Project Gutenberg (**www.snipca.com/44263**).

Notable titles include *To the Lighthouse* by Virginia Woolf, *The Case-Book of Sherlock Holmes* by Sir Arthur Conan Doyle and HP Lovecraft's *The Colour Out of Space*, but due to the difference in copyright law, all three are already available from the excellent site Global Grey (**www.snipca.com/44264**). This offers more than 2,400 public- domain ebooks from hundreds of famous authors to download legally for free. You can choose between PDF, EPUB and MOBI formats, depending on which device you plan to read on (none of the books are DRM-protected), and don't need to register any details - just click the relevant Download button (see screenshot above).

12 Audiobooks you don't have to pay for

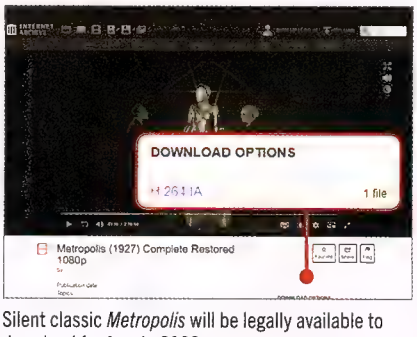
If you prefer listening to books to reading them, the audiobook service LibriVox (**www.snipca.com/44270**) will also be adding lots of newly out-of-copyright titles in 2023. It already offers more than 45,000 audiobooks, which are read by volunteers from all over the world and can be downloaded as ZIP files containing MP3s of each chapter (see screenshot above). All the content is free to download, unlike Spotify's new Audiobooks section. Why pay the streaming service to hear AA Milne's *Winnie-the-Pooh* (which entered the public domain at the start of 2022) when you can choose from three free versions on LibriVox (**www.snipca.com/44265**)?

The free LibriVox Audio Books app for Android (**www.snipca.com/44266**) and iOS (**www.snipca.com/44267**) lets you browse its library on your phone or tablet, download audiobooks to listen to offline and stream them to a Bluetooth speaker or Chromecast device.

13 Classic films that are now out of copyright

As with books, films that were copyrighted in the US in 1927 will enter the public domain in 2023, so you'll be able to download them for free without fear of prosecution. Some are already available on the Internet Archive and YouTube, but probably shouldn't be, and their picture quality varies greatly. We expect to see remastered versions appear online over the next year, which should delight anyone interested in the history of cinema.

Classic movies that will be legal to download in 2023 include *The Jazz Singer*, the first feature-length film with synchronised sound and spoken dialogue – or 'talkie' for short. You can watch and download it now at **www.snipca.com/44273** if you can't wait. Another cinematic landmark, Fritz Lang's dystopian masterpiece *Metropolis*, will also enter the public domain, or rather re-enter following a complicated copyright history. Again, this is already available to download from the Internet Archive (see screenshot left) – the two-and-half-hour-long 'complete restored' version (**www.snipca.com/44274**) is the best one to watch.



Silent classic *Metropolis* will be legally available to download for free in 2023.

Other films whose copyright expires in 2023 include Alfred Hitchcock's first thriller *The Lodger: A Story of the London Fog* (**www.snipca.com/44275**), *Clara Bow in It* (**www.snipca.com/44276**) and FW Murnau's silent classic *Sunrise* (**www.snipca.com/44277**).

14 Royalty-free music and sounds from YouTube

YouTube has announced plans to launch a service called Creator Music in 2023, and is already testing it in the US. This will allow 'creators' to find and license songs for their YouTube videos without having to share their ad revenue with music-copyright holders. It sounds useful for people who earn their livelihood through YouTube, but the rest of us can download free music to use in videos and other projects from the existing YouTube Audio Library.

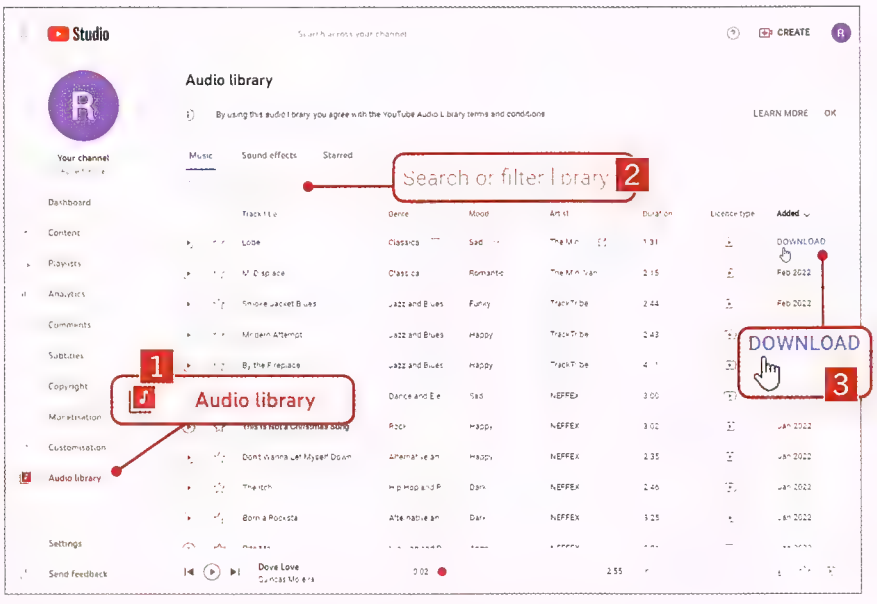
To access this feature, visit YouTube Studio (**www.snipca.com/44285**) and click 'Audio library' on the left (1 in our screenshot below) to browse nearly 1,750 royalty-free tracks. Click the 'Search or filter library' button 2 to filter the list by genre, mood and duration, then click the play button to hear a track in your browser. Click 'Download' 3 to save the audio to your PC in MP3 format.

Considering that all the music is free, it's good quality and includes classical pieces as well as country and folk, jazz and blues, and much more. YouTube Audio Library also lets you download hundreds of free sound effects, with descriptive names such as 'Toilet flush small bathroom' and 'Tamping soil'.

15 High-quality photos and graphics

In November, the stock-photo website Dreamstime launched a new 'freemium' plan, which lets you download thousands of high-quality, royalty-free images without paying for a subscription. This makes it ideal for sourcing photos, illustrations, abstract graphics and more for use in your personal and professional projects.

You need to sign up for a free Dreamstime account, which confusingly asks you to choose a payment plan, but ignore this and head to the Free Photos section (**www.snipca.com/44300**). Here you download free images with a single click – these are usually in JPEG format with a 300dpi resolution.



Download MP3s of royalty-free music from YouTube's Audio Library to use however you want.

Dreamstime may ask you to credit the photographer.

Adobe Stock also has a huge collection of free stock photos and graphics at **www.snipca.com/44301** – you'll need an Adobe ID to download them.

16 High-resolution copies of famous artworks

Throughout 2022, climate protestors expressed their eco-rage by vandalising famous works of art in galleries around the world. Ensure you have pristine versions of your favourite in 2023 paintings by downloading high-resolution copies from Artvee (**https://artvee.com**).

This site lets you browse more than 6,000 artworks from hundreds of notable artists, and save them to your hard drive to use as you please – they're all in the public domain, so you needn't worry about copyright. These include paintings that recently suffered attacks, including Gustav Klimt's Death and Life, Johannes Vermeer's Girl with a Pearl Earring (pictured) and Raphael's Sistine Madonna.

It's free to download high-quality images of each work, but to get the massive, maximum resolution versions you need an Artvee Pro subscription (US$7.99 a month).

17 Free flight simulator

Microsoft recently celebrated the 40th anniversary of its *Flight Simulator* in November by adding helicopters and gliders, as well as more airports. Although the update is free to install, the full *Microsoft Flight Simulator 40th Anniversary Edition* costs from $99.95 to buy. This may currently be too expensive for all but the highest fliers, so why not take to the skies for free in 2023 by downloading *FlightGear* (**www.snipca.com/44309**)?

This amazing open-source flight simulator puts you in the cockpit of hundreds of planes, helicopters (pictured above right) and other aircraft, and lets you fly to and from 40,000 real-world airports. *FlightGear* is a big download (1.8GB) and its controls take a while to master, but there's plenty of online help at **www.snipca.com/44310** and it was recently updated to make flying smoother than ever.

Take to the skies for free in a plane or helicopter by downloading *FlightGear*.

Save money in 2023 by downloading life-simulation game *The Sims 4* for free.

18 Life-simulation game *The Sims 4*

Even if you don't often play video games, you're probably familiar with *The Sims*, the popular 'life-simulation' game in which you create a virtual character, build and furnish a house, then explore your 3D environment and interact with other characters. In October, the game's developer, EA, made the most recent version (*The Sims 4*) free to download on computers and consoles.

There are two ways to download *The Sims 4* to your PC in 2023. The easiest is to install EA's desktop app (**www.snipca.com/44297**), create a free account and find the game – it should be on the home screen under 'Top games'. Click 'Download' (see screenshot above) to save *The Sims 4* to your hard drive – note that it requires nearly 20GB of free space.

Alternatively, you can download it – and other free titles – by installing the Steam app (**www.snipca.com/44298**). Although *The Sims 4* is now free, you need to pay for add-ons to get extra items and skills. ■

WILL WINDOWS 11 REMAIN FREE IN 2023?

It's currently free to upgrade to Windows 11, and has been since it launched in October 2021. But it's possible that Microsoft may start charging users for the new operating system in 2023.

Windows 10 was available as a free download for its first year of release, but that ended after July 2016 for upgrades from Windows 7 or 8.1. It's now been nearly 15 months since Windows 11 arrived and Microsoft has yet to confirm when the free offer will end. In the 'Frequently asked questions' section of the 'How to get Windows 11' site (**www.snipca.com/44289**), it states only that "the free upgrade offer does not have a specific end date", but that it "reserves the right to eventually end support for the free offer".

It's likely that Windows 11 will continue to be offered for free because uptake has been slow – and so far only around 15 per cent of PC users have upgraded. In comparison, around 25 per cent had moved to Windows 10 after the same length of time. Charging for an operating system that people are unwilling or unable to install would be bad business sense, especially during a cost-of-living crisis. So we predict Windows 11 will remain free until at least its two-year anniversary in October and possibly for good if Microsoft launches Windows 12 in 2024.

The Compact Cassette revolutionised portable audio and mainstreamed for nearly 40 years (Image credit: Thegreenj, CC BY-SA 3.0).

FEATURE - PART 3

(R)evolution of Portable Audio:

Tape goes 'compact'

Billions of them were made, they'd fly to the moon, frustrate home computer users and launch the original mix-tape. Darren Yates looks back at the rough-and-tumble story of the audio-cassette.

Dutch engineer Lou Ottens isn't a household name – but he should be. Reel-to-reel tape recorders were fast becoming commodity items by the early-1960s and while the transistor had been responsible for new portable designs, the tape system itself still required the dexterity of a surgeon, as users navigated lacing the tape around pinch-rollers, guides and heads. Efforts to encase the tape reels into a simple snap-load cartridge system weren't new. However, it would eventually take two technology giants playing 'hardball' to get Ottens' new technology its place in history.

Right: The Sony Elcaset had potential but arrived five years too late (Image credit: Akakage1962 & Retired electrician, CC BY 3.0).

Below: The Commodore 'Datasette' stored programs from the PET, VIC-20 and 64 computers on cassette (Image credit: Public Domain).

Musical chairs

Work on an audio-cassette began back in the 1950s, with the huge Radio Corporation of America (RCA) releasing the 'Sound Tape Cartridge' in 1958. However, despite its clear convenience over reel-to-reel tape, the format disappeared six years later. Suggested reasons for its failure vary, but RCA's slowness to release pre-recorded music tapes and domestic players is often cited.

Meanwhile in Europe, German maker Grundig was the 'market goliath' in tape recorders and in 1961, reportedly partnered with Dutch giant Philips to create an audio-cassette. The problem for Grundig was Philips also had its Belgian team (including engineer Lou Ottens) working on an alternate design. Ottens' 'Pocket Recorder' design eventually won out, leaving Grundig's joint-effort out in the cold. Despite Philips' offer to Grundig to join its 'Pocket Recorder' group, Grundig was having none of it and instead, released the rival music-focussed 'DC-International' cassette with fellow-German maker Telefunken in 1965. However, it failed to catch on and by 1968, it was gone.

RCA and Grundig essentially missed the bus – RCA missed its first-to-market opportunity and Grundig was just too late. Philips, with Ottens' renamed 'Compact Cassette', won the market, but a high-stakes battle with Japanese heavyweight Sony would ultimately see Philips win a hollow victory.

The 1963 Berlin IFA Exhibition

Some 28 years after AEG demonstrated its 'Magnetophon' reel-to-reel tape recorder at the Berlin Radio Show (see *APC* last month), Philips arrived with its 'Pocket Recorder' in August 1963. The reception was reportedly muted, though it's suggested Japanese manufacturers at the show were impressed. As RCA was finding out (and tech brands still learn years later), creating a global media format on your own is a hard slog. Still, Philips no doubt had hopes for its cassette format becoming a stream of ever-flowing royalties from other hardware makers – but it knew if it was to win the market, it needed the fast-growing Japanese makers on-board, starting with Sony.

This time, however, Grundig got to Sony first. The Sony team weighed up the Pocket Recorder and DC-International proposals, but chose the smaller Philips unit. Philips may now have anticipated an 'easy win' and came at Sony with a 25-yen (seven US cents in 1965) per-unit-sold royalty contract. Sony's response was effectively 'yeah, nah', expecting Philips to go away and 'sharpen the pencil'. Philips obliged soon afterwards, but dropped the royalty a whopping 75 percent to just 6-yen per unit.

Sony must have sensed the tide was turning in its favour, for it now demanded Philips either drop its royalties completely, or Sony would choose Grundig. For Philips, this must have come as a shock – either it now caved in to Sony and forgot the royalties, or, it stuck to its guns and fought a united Sony-Grundig front for the cassette market. In the end, Philips dropped the royalties, but ensured Sony didn't get exclusive rights.

As for Grundig, it lost out in the middle of the Sony-Philips battle – by 1966, Japanese manufacturers were churning out cassettes and recorders by the bushel and the following year, the recently-renamed 'Compact Cassette' had won. However, the Sony fight had cost Philips all hope of royalties.

When the dust settled, the real winner to emerge was Sony.

Fly me to the moon

Meanwhile, Sony continued with its healthy business of making and selling tape recorders and cassettes. One of those recorders was a 1968 design that could be operated in one hand. NASA saw it and thought it could be a great way for Apollo astronauts to record mission log notes. The result was the Sony TC-50, the first 'notetaker' cassette recorder, hitching a ride on every mission, beginning with Apollo 7 and orbiting the moon on Apollo 10. In a twist, it's likely the Apollo missions also invented the mix-tape, with each astronaut carrying tapes with their favourite music.

Above: The Nakamichi Dragon, arguably the ultimate cassette deck, will cost you beyond $5,000 today (Image credit: Bbadgett, CC BY-SA 4.0).

How the Compact Cassette improved

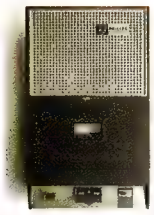
Despite all this, however, the original 1960s' Compact Cassette wasn't well-suited to music – it was originally meant for voice-recording. In simple terms, early Compact Cassette recorders were better than analog AM radio, but not as good as an analog FM receiver.

Even by 1960, it was understood that high-fidelity audio needed tape that was as wide as possible, running as fast as commercially viable. Music tapes in the 1960s (including the popular American '8-track' system) delivered two-channel 'stereo' sound on 6.35mm (¼-inch)-wide tape with a play speed of 9.5cm/second (3.75-inch). The Compact Cassette tape, however, was just 3.175mm (1/8-inch) wide, had a play speed of 4.75cm/second (1.875-inch) and single-channel only. With half the width, tape hiss (affecting 'signal to noise ratio' or SNR) was much more noticeable and at half the speed, the frequency response was considerably lower. But with these specs baked into the Compact Cassette standard, what could be done?

It became a technological battle on multiple fronts. The first cassettes used Ferric-Oxide particles on PVC plastic tape, but in 1968, the U.S. chemical giant DuPont commercialised Chromium-Dioxide (CrO_2) and the big German tape maker BASF created the first 'chrome' cassettes in 1970. These moderately improved SNR and frequency response.

Below: Grundig's DC-International cassette was a brief competitor during the mid-1960s (Image credit: Ulrich Miemietz, CC BY-SA 3.0).

Below: Compact cassettes featured in 1970s' home computers, including the Commodore PET (Image credit: Parrot of Doom, CC BY-SA 4.0).



Above: The shoebox-style Philips EL3300 was the very first Compact Cassette recorder (Image credit: Erkaha, CC BY-SA 4.0).

Noise Reduction – Dolby and dbx

The second step was electronic. Today, Dolby Atmos is a multi-channel audio processing system developed by Dolby Laboratories, found in everything from cinemas to phones. But back in 1965, Dolby Labs was just Ray Dolby, an electrical engineering graduate from Stanford and Cambridge universities, who created a technology that would soon tackle the background-hiss problem.

Dolby figured out that our perception of background noise occurs in the higher frequencies, rather than the lower ones. So, he split the higher-frequency sounds into a separate stream or 'band' and electronically-increased the audio level of those frequencies during recording onto tape.

During playback, he just did the reverse – he reduced those frequencies by the same amount, effectively returning the audio to its original levels. However, the difference was that on playback, the background hiss was also reduced by that same amount (this hiss wasn't increased or 'amplified' during recording because it is a function of the tape, not the audio signal). The result was a reduction in background noise by as much as 10dB (a bit over 3x) – and Dolby 'B' Noise Reduction was born.

But Dolby wasn't the only option. A more complex system known as 'dbx' was invented in 1971 by engineer David Blackmer. Whereas Dolby split the audio spectrum into different bands, dbx applied the 'companding' (compression-expanding) process to the whole audio spectrum. At its peak, dbx-encoded cassettes could achieve a near-Compact Disc SNR approaching 90dB. However, Dolby-B-recorded tapes were still listen-able without a proper decoder, whereas dbx tapes weren't – this helped Dolby-B become the more-popular commercial choice amongst record labels.

Above: The 1958 RCA Sound Tape Cartridge was the first serious attempt at an audio-cassette (Image credit: Public Domain).

The cassette 'deck'

Nevertheless, this was all still just technology in 1971. Late-1960s' cassette recorders were predominantly 'shoebox' style units, like the original single-channel Philips EL-3300. The Advent 201 became the first stereo cassette 'deck' to offer Dolby noise reduction and CrO2 tape support, glimpsing the Compact Cassette's future potential for high-fidelity audio.

In 1973, Japanese brand TEAC launched the A450 as the first reel-to-reel rival. It came with Dolby and CrO2 support, improved frequency response and lower 'wow and flutter' than the Advent. Because cassettes had a mechanical-drive system, any variation in tape speed could be heard as either long drawn-out 'wow' or fast, short 'flutter' changes in the audio pitch. While the Advent 201 achieved a decent 'W&F' figure of 0.15 percent, the tank-like A450 dropped this to just 0.07 percent, unheard of in cassettes in 1973.

However, that year, a well-respected but lesser-known Japanese audio company effectively said to TEAC 'hold my beer'. That company was Nakamichi. Born in 1948, Nakamichi was making cassette decks for brands including Harman-Kardon by 1970, but in 1973, it began selling new decks under its own name. The first two models – the 700 and 1000 – combined Dolby and CrO2 support with a raft of new features, but added a new dimension. Nakamichi developed a new playback head, the electromechanical device that read the audio signal from the tape. Its key feature was a head gap (over which tape passes) much smaller than previously possible at just 0.7-micron (0.0007mm). This smaller gap delivered a much-improved frequency response and for the first time, the Compact Cassette could capture the audio spectrum right up to 20kHz. Move over, reel-to-reel.

One last hurrah: the Sony Elcaset

By 1967, the Compact Cassette had seen off RCA's Sound Tape Cartridge and the Grundig-Telefunken DC-International cassette. So, it still seems odd Sony would have a dash at the cassette market itself nine years later.

The Sony 'Elcaset' (L or Large-Cassette) was technically very good, albeit similar to the old RCA system, with twice the tape width and speed of the Compact Cassette. However, despite Sony's quality engineering, the Elcaset market barely lasted three years.

So what made Sony do it? There's no doubt by 1971, the Compact Cassette was struggling to improve audio quality. Dolby-B noise reduction improved the SNR aspect but couldn't solve the wider magnetic and mechanical issues. Sony wanted a cassette system to rival reel-to-reel and built Elcaset for the job. Unfortunately, creating a new cassette system isn't something you did quickly and its likely Sony hit the 'go' button near to Nakamichi launching the Model 1000. By the time the Elcaset arrived, Nakamichi had the Compact Cassette largely knocked into shape and Sony was left with a

Below: The Swiss-made Revox B215 rivalled the Nakamichi Dragon for audio quality (Image credit: Public Domain).

proprietary design about five years too late.

Still, it wasn't all bad for Sony – the Elcaset might have expired by 1979, but the Japanese giant was about to embark on a new brand that would enter technology folklore.

The Sony Walkman

While Nakamichi focussed heavily on Hi-Fi, Sony was already known for portability, producing a number of portable recorders during the 1970s. This culminated in the legendary TC-D5 in 1979. In fact, the TC-D5 was so good, it was manufactured in various models for nearly 25 years and used by radio and TV journalists around the world.

One of its first users was Sony founder Masaru Ibuka, who favoured it as a travelling companion. However, whilst it delivered near-studio quality in a portable, the TC-D5 was comparatively heavy and deputy president Norio Ohga was tasked to come up with a stereo headphone-playback-only version of Sony's recent TCM-100B 'Pressman' notetaker.

Combining new electronics with the Pressman's sturdy tape mechanism, the result was the iconic TPS-L2 hitting Japanese store shelves in July 1979, just four months after the concept was sketched. Sony hoped to sell 5,000 a month – it sold 30,000-plus in the first two and the 'Walkman' was born. They appeared in music videos, movies, rewrote pop culture and still do today – the TPS-L2 recently found a new generation of fans through Marvel's *Guardians of the Galaxy* movie franchise and now, the going rate for a working TPS-L2 is typically $1,000, minimum.

Home computer storage

By the mid-1970s, the cassette wasn't just for storing music, but also computer code. The 'home computer' revolution started by the Commodore PET and Tandy TRS-80 in 1977 took advantage of audio cassettes as cheap data storage devices. In fact, cassette tape served as the storage medium-of-choice for many home computers, including the ZX Spectrum, Amstrad CPC464, the Commodore VIC-20 and 64 into the 1980s. In 1982, the Commodore 64 delivered its first floppy disk drive, saving home-coders who'd wait nervously for programs to slowly load from a tape.

Above: The Sony TC-D5 is still mentioned in hushed tones by tape enthusiasts (Image credit: KnowledgeIsImportant, CC BY-SA 4.0).

Above: The 1970s' range of TEAC reel-to-reel recorders is still legendary today (Image credit: Rybkovich, CC BY-SA 4.0).

A revolution in sound

In a way, the Compact Cassette is just another chapter in the broader story of technology. It began as something of an oddity, but kicked along by engineers and companies over 20 years, it became a global phenomenon. That it thrived as a consumer technology for 30 years is testament to how forward-thinking the Compact Cassette was when it arrived in 1963. Three cheers, Lou Ottens!

But when you consider the size of cassette decks compared with the cassette itself, it's the Sony Walkman that took the cassette to its ultimate conclusion. The Walkman didn't make the cassette portable – it made using the cassette portable. It mightn't have rivalled a Nakamichi Dragon for audio quality, but when it came to sitting on a crowded bus for two hours, nothing beat pulling out your Walkman and entering your own little world.

Another 'new' revolution beckons

Technology is never invented or created in isolation – in any technology genre, you almost always find a popular technology on the slide, one that's in its heyday and another coming to take its place. Even in the 1970s' heyday of the Compact Cassette, its successor was well on the way. Next time, we go back to the mid-1970s and re-trace the story of two technology antagonists joining forces to launch a new revolution that's still with us today. ■

Above: The Sony Walkman TPS-L2, as recommended by guardians throughout the galaxy (Image credit: Binarysequence, CC BY-SA 4.0).

Worker drones are here

Bennett Ring buzzes into the clouds as he examines the new breed of commercial drones making our lives better

KTV Australia is using the unique accessibility a drone offers for tasks like window cleaning.

It's hard to believe that DJI's first drone, the Phantom, launched just ten short years ago. In that brief period of time over five million consumer drones have sold around the world, made possible by a confluence of several key technologies: the global GPS network; affordable ultrasonic, laser, and vision sensors; miniaturised gyroscopes and accelerometers; and increased battery capacity. Until recently, most of these drones were purchased by drone enthusiasts, photographers and videographers, but in the very near future we can expect to see them becoming part of a global robotic workforce. Advancements in machine learning allow these drones to autonomously perform jobs ranging from package deliveries for Amazon, to patrolling the interior of your home for burglars. Let's take a look at some that are nearing release.

Skydio Dock

Launched at the end of 2022, this autonomous kit allows companies to patrol their worksites without requiring a human pilot. At the heart of the package is either the Skydio 2+ or X2 quad-copter drone, trained to follow a pre-determined route around a site on its own. Thanks to the six fish-eye cameras combined with an Nvidia Tegra chip, it can detect and avoid obstacles that may not have been there during the training. Once the patrol is complete, the drone flies back to the Dock, touching down on a retractable landing pad, which then slides neatly back into the weather-proof box. Once tucked away the drone charges itself, ready to patrol the skies again within hours. Designed for both repetitive and dangerous visual inspections, humans are still required to view the footage captured... for now.

Ring Always Home Cam

Not content with capturing videos of intruders via boring, stationary cameras, Ring's new home security drone takes the smarts of a regular autonomous drone, but repurposes it in a smaller package to patrol the wild back-corridors of... your home. It's basically a cut-down version of the Skydio system, but designed for your house. Setup is simple – plug in the base, disconnect the T-shaped drone, and carry it on the route you'd like to patrol in your house. The drone uses accelerometers and vision to record the route, enabling it to then fly it whenever you're out and about. Once it's made sure your pets aren't humping the furniture, it lands back at the dock, recharges, and is ready to do it all over again. There's no ability to control the drone manually, and it'll only record video when it's flying through your

Skydio Dock's system allows inspection of work sites remotely.

Ring Always Home Cam is a mobile surveillance camera, able to follow routine patrols.

Wing is beginning home delivery services for clients like Coles, with deliveries in QLD underway.

house, captured via the 1440 x 1440 camera, which can also handle low-light conditions. While it's programmed to fly the route at specific times, it will also zip over to see what's happening if any Ring alarm sensors are triggered, allowing the owner to see exactly what their household ghost has knocked over this time. Cue some hilarious Home Alone scenes once people start modifying their security drone. It looks like Ring may have hit some snags with the release; announced in 2020, it was due to ship this year, but has now been pushed to 2024.

Wing unmanned deliverydrones

Forget Amazon, a start-up by the name of Wing is the first company to offer drone deliveries of products here in Australia. Partnering with DoorDash, a company known for bringing hot Chinese take-away to your front door in minutes, the company is now offering on-demand drone delivery of "convenience and grocery items, pantry staples, snacks, and household essentials". The service is currently operating in the country town of Logan, and promises to have the cure to your munchies in 15 minutes or less. We're a little surprised to see such simple items being offered, as we imagine shooting a drone out for delivery isn't exactly cheap.

Coles is another customer to partner with Wing to offer deliveries, via its store-to-the-door programme. If you live in the Gold Coast suburbs of Ormeau, Ormeau Hills, and Yatala, you can get delivery of your Coles order in mere minutes. Orders are processed at the Coles in nearby Ormeau Village, and offers up to 500 different Coles products (the service is also offered in Canberra... but nobody cares about Canberrans).

Frankly we're a little surprised that

Skye Unmanned Traffic Management is tackling crowded drone routes, allowing more to operate safely.

the technology is being offered to deliver bags of Fantales instead of first-aid kits to travellers stuck in the bush, but we guess Wing has to go where the money is. Besides, what better way is there to impress your house party guests than getting a bag of chips dropped off by an overhead drone?

KTV Australia working drones

Drones are well suited to getting to those hard-to-reach places that are both costly and dangerous for squishy human beings. Take window cleaning as an example – it's known as one of the more life-endangering professions around. Thankfully the rapid evolution of drone payload capacity means we now have drones like KTV's working drones, which specialise in window and building cleaning. The drones carry a pressurised sprayer up to heights of 100 metres, and first gives the window or wall a good dousing with a cleaning solution. A quick hose-change later, and it's blasting away the grit with water, while a case filled with replacement batteries means it can work for as long as you need. It's not fully autonomous though, requiring a drone operator to stand nearby and pilot the drone. Still, it beats hanging off the side of a building.

Skye Unmanned Traffic Management

If you thought the road traffic in India was eye-opening (recording the highest road fatalities of any country), wait until you see their drone airways. Well, we assume they're pretty damn busy, otherwise there'd be no need for the Skye UTM drone. Apparently there's a lot of drone traffic in India, and this little self-aware box ensures they all fly around without issue. It's designed to fly without human monitoring, and keeps track of all drones in a certain airspace. It pushes out information to all of these drones, to ensure they're not flying where they shouldn't be, and delivers a 3D map of the airspace showing all potential drone routes. Seriously though, there's definitely a need for drones like this around areas where drone use needs to be highly controlled, such as airports or power plants. ■

TABLETS

FROM $99 TO $1,799

How do you choose between the current iPads? What are the best Android tablets on the market? And can you get away with a cheapie? We answer these questions and much more.

There's an argument that the tablet is the ultimate personal computer: no other computing device balances mobility, speed and ease of use so effectively. But the word "tablet" is deceptive in its simplicity. Tablets can be cheap and functional, but others deliver a high-spec, premium experience. And they're also incredibly customisable: add a keyboard or stylus and the same device you used to watch Elf can be transformed into the perfect tool to edit your own 4K video. A tablet is at once a media player, an ebook reader and a handheld games machine – or simply the perfect vehicle for browsing and social media. Perhaps the most confusing thing about tablets is their sheer diversity. While the basic format has changed little since the iPad launched, even Apple's range scales from compact slates to tablets so powerful and capable they could replace your laptop. Outside the Apple universe, you're looking at everything from $100 devices aimed at media consumption to $1,800 models with massive screens and every feature you could wish for. Somewhere in that spectrum is the right tablet for you – and we've tested 13 of the best to help you find it.

CONTRIBUTOR: Stuart Andrews

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				LABS WINNER		
	[illegible]	[illegible]	Apple iPad (10th generation)	Apple iPad Air (5th generation)	Apple iPad mini (6th generation)	Apple iPad Pro 12.9 (5th generation)
OVERALL RATING	★★★☆☆	★★★★☆	★★★★☆	★★★★★	★★★★☆	★★★★★
Base storage	16GB	32GB	64GB	64GB	64GB	128GB
Price [1]	$99	$135	$719	$997	$827	$1,899
Storage options	32GB	64GB	256G	256GB	256GB	256GB, 512GB, 1TB, 2TB
Cellular option	N/A	N/A	64GB, 256GB	64GB, 256GB	64GB, 256GB	128GB, 256GB, 512GB, 1TB, 2TB
Generation	12	12	10	5	6	5
Supplier	amazon.com.au	amazon.com.au	apple.com/au	apple.com/au	apple.com/au	apple.com/au
Dimensions	181 x 118 x 9.7mm	202 x 137 x 9.6mm	249 x 180 x 7mm	248 x 179 x 6.1mm	195 x 135 x 6.3mm	281 x 215 x 6.4mm
Weight	282g	337g	477g	461g	293g	682g
CUSTOMER SERVICE						
Warranty	1yr RTB	1yr RTB	1yr RTB	1yr RTB	1yr RTB	1yr RTB
CORE COMPONENTS						
Chipset	MediaTek MY8168V	MediaTek MT8169A	Apple A14 Bionic	Apple M1	Apple A15 Bionic	Apple M2
Number of cores	4	6	6	8	6	8
Clock speed	2GHz	2GHz	2.99GHz	3.2GHz	2.9GHz	3.49GHz
Installed RAM	2GB	3GB	4GB	8GB	4GB	8GB to 16GB
Graphics chip	Mali-G52	Mali-G52	4-core A14	8-core M1	5-core A15	10-core M1
CONNECTIVITY AND EXPANSION						
Wi-Fi	Wi-Fi 5	Wi-Fi 5	Wi-Fi 6	Wi-Fi 6	Wi-Fi 6	Wi-Fi 6E
Bluetooth	5 LE	5.2 LE	5.2	5	5	5.3
GPS	✗	✗	5G models only	5G models only	5G models only	5G model only
NFC	✗	✗	✗	✗	✗	✗
Audio jack	✓	✓	✗	✗	✗	✗
MicroSD	✓	✓	✗	✗	✗	✗
Charging port	USB-C	USB-C	USB-C	USB-C	USB-C	USB-C
USB speed	480Mbits/sec	480Mbits/sec	480Mbits/sec	10Gbits/sec	5Gbits/sec	40Gbits/sec
DISPLAY						
Screen size and type	7in IPS	8in IPS	10.9in IPS	10.9in IPS	8.3in IPS	12.9in mini-LED
Resolution	1,024 x 600	1,280 x 800	2,360 x 1,640	2,360 x 1,640	2,266 x 1,488	2,732 x 2,048
Aspect ratio	16:09	16:10	4:3	4:3	4:3	4:3
Pixel density	171ppi	189ppi	264ppi	264ppi	326ppi	264ppi
Max brightness (measured)	402cd/m^2	492cd/m^2	504cd/m^2	529cd/m^2	526cd/m^2	591cd/m^2
OTHER FEATURES						
Rear camera	2MP	2MP	12MP	12MP	12MP	12MP + 10MP
Front camera	2MP	2MP	12MP	12MP	12MP	12MP
Fingerprint reader	✗	✗	✓	✓	✓	✗
Face unlock	✗	✗	✗	✗	✗	✓
Battery capacity	2,980mAh	4,850mAh	29Wh	29Wh	19Wh	41Wh
Max charging	5W	5W	20W	30W	20W	45W
Charger supplied	5W	5W	20W	20W	20W	20W
Wireless charging	✗	✗	✗	✗	✗	✗
Other	✗	✗	✗	✗	✗	✗
SOFTWARE						
Operating system	Fire OS 8.3.1.2	Fire OS 8.3.1.2	iPadOS 16	iPadOS 16	iPadOS 16	iPadOS 16
App store	Amazon	Amazon	Apple App Store	Apple App Store	Apple App Store	Apple App Store
Widevine support	Widevine L1	Widevine L1	Widevine L1	Widevine L1	Widevine L1	Widevine L1
OFFICIAL ACCESSORIES						
Keyboard	✗	✗	Magic Keybard Folio	Smart Keyboard Folio, Magic Keyboard	N/A	Magic Keyboard
Stylus	✗	✗	Apple Pencil 1st gen	Apple Pencil 2nd gen	Apple Pencil 2nd gen	Apple Pencil 2nd gen
Other	Kid-Proof Case , Fabric Cover	Kid-Proof Case, Cover	Smart Folio case	Smart Folio Cover	Smart Folio cover	Smart Folio case

1 Prices correct at time of going to press but are subject to change.

Huawei MatePad 11	Lenovo Tab P11 Pro Gen 2	Lenovo Tab P12 Pro	[illegible] Tab	Oppo Pad Air	Samsung Galaxy Tab S8	Samsung Galaxy Tab S8 Ultra
★★★★☆	★★★★★	★★★★★	★★★★☆	★★★☆☆	★★★★☆	★★★★★
128GB	256GB	128GB	32GB	64GB	128GB	128GB
$949	$597	$449	$272	$379	$799	$1,799
64GB	N/A	64GB	N/A	N/A	256GB (£699)	256GB, 512GB
N/A	N/A	N/A	32GB	N/A	128GB , 256GB	128GB, 256GB, 512G
1	2	1	1	1	8	1
consumer.huawei.com	lenovo.com/gb	lenovo.com/au	nokia.com	oppostore.com	samsung.com/au	samsung.com/au
255 x 165 x 7.3mm	264 x 167 x 6.8mm	286 x 185 x 5.6mm	208 x 132 x 9mm	245 x 155 x 6.9mm	165 x 254 x 6.3mm	209 x 326 x 5.5mm
485g	480g	565g	375g	440g	503g	726g
2yr RTB	1yr RTB	1yr RTB	1yr RTB	1yr RTB	1yr RTB	1yr RTB
Qualcomm Snapdragon 865	MediaTek K1300T	Qualcomm Snapdragon 870	Unisoc T606	Qualcomm Snapdragon 680	Qualcomm Snapdragon 8 Gen 1	Qualcomm Snapdragon 8 Gen 1
8	8	8	8	8	8	8
1.8GHz to 2.84GHz	2.6GHz	3.2GHz	1.6GHz	2.4GHz	1.7GHz to 2.99GHz	1.7GHz to 2.99GHz
6GB	8GB	6GB	3GB	4GB	8GB	8GB to 16GB
Quacomm Adreno 650	Mali-G77 MC9	Qualcomm Adreno 650	Mali-G57 MP1	Quacomm Adreno 610	Qualcomm Adreno 730	Qualcomm Adreno 730
Wi-Fi 6	Wi-Fi 6	Wi-Fi 6	Wi-Fi 5	Wi-Fi 5	Wi-Fi 6	Wi-Fi 6
5.1 LE	5.1	5.2	5	5.1 LE	5.2	5.2
✓	✓	✗	4G model only	✗	✓	✓
✗	✗	✗	✗	✗	✗	✗
✗	✗	✗	✓	✓	✗	✗
✓	✓	✓	✓	✓	✓	✓
USB-C	USB-C	USB-C	USB-C	USB-C	USB-C	USB-C
10Gbits/sec	5Gbits/sec	10Gbits/sec	480Mbits/sec	480Mbits/sec	10Gbits/sec	10Gbits/sec
10.95in IPS	11.2in AMOLED	12.6in AMOLED	8in IPS	10.36in IPS	11in IPS	14.6in Super AMOLED
2,560 x 1,600	2,560 x 1,536	2,560 x 1,600	1,280 x 800	2,000 x 1,200	2,560 x 1,600	2,960 x 1,848
16:10	16:10	16:10	16:10	16:10	16:10	16:10
275ppi	266ppi	239ppi	189ppi	225ppi	274ppi	240ppi
468cd/m^2	473cd/m^2	404cd/m^2	446cd/m^2	347cd/m^2	463cd/m^2	583cd/m^2
13MP	13MP	13MP + 5MP	8MP	8MP	13MP + 6MP	13MP + 6MP
8MP	8MP	8MP	2MP	5MP	12MP	12MP
✗	✓	✓	✗	✗	✓	✓
✓	✗	✗	✗	✓	✓	✓
7,250mAh	8,200mAh	10,000mAh	5,250mAh	7,100mAh	8,000mAh	11,200mAh
22.5W	20W	30W	10W	18W	45W	45W
22.5W	20W	30W	Not supplied	18W	Not provided	Not provided
✗	✗	✗	✗	✗	✗	✗
✗	✗	✗	✗	✗	✗	✗
Harmony OS 2	Android 12	Android 12	Android 12	ColorOS for Pad	Android 12/One UI	Android 12/One UI
Huawei AppGallery	Google Play Store	Google Play Store	Google Play Store	Google Play	Google Play Store	Google Play Store
Widevine L1	Widevine L1	Widevine L1	Widevine L1	Widevine L1	Widevine L1	Widevine L1
Included	Lenovo Keyboard Pack	Lenovo Keyboard Pack	N/A	✗	Keyboard slim book cover	Tablet Case & Keyboard
Included	Lenovo Precision Pen 3	Lenovo Precision Pen 3 (included)	N/A	✗	S-Pen (included)	S-Pen (included)
✗	Folio Case	Folio Case	Nokia Flip Case	✗	Standing cover	Standing cover

Seven questions to ask before taking a tablet

Our reviews give a fantastic insight into each machine's merits, but before you make a costly decision make sure you've answered all the key questions

It's easy to take a sledgehammer/walnut approach to tablets and spend more than you need, but just as easy to go too cheap and end up disappointed with your tablet and its limited capabilities. That's why you should start by considering what you want or need a tablet for and the size you're going to be comfortable using; then think about your budget.

Above: Go large on screen size if you plan to use your tablet for productivity tasks.

1 Do you need to go large?

Small-screen 7in to 9in tablets have fallen out of high-end fashion, but if you're looking for a media consumption device then they still make a lot of sense. They're lighter and more portable than the bigger-screen tablets, but have more usable screen space than your smartphone, particularly for watching videos, playing games, reading ebooks or browsing the web. The lower weight and smaller size also make a difference if you're using the device handheld for extended periods, or planning to use it on a plane or train.

Mid-sized tablets with 9in to 11in screens are larger and heavier, but the advantages of a bigger screen might make the shift up worth your while. You'll have more space for browsing and online shopping, a more immersive streaming experience, and more screen real estate for running demanding image-editing or productivity apps. It's at this size, too, where add-on keyboards become worthwhile; clip one on and a decent mid-sized tablet can become a mobile workhorse.

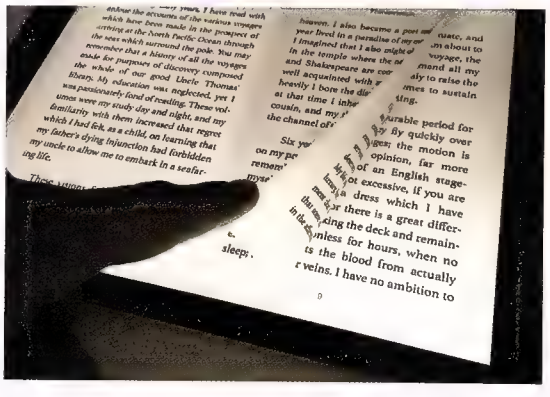
Big-screen tablets (11in and up) cross further into laptop territory, with even more space for apps and multitasking. However, the larger you go, the more comfort and portability become an issue, although even a 12.9in tablet is going to be lighter and more practical in some conditions than the equivalent 13in laptop.

2 How much power do you need?

It's no surprise that budget tablets come with low-cost, low-performance processors and limited quantities of RAM. The specs will still be fine for streaming HD video, reading ebooks and browsing the web, but you'll find the experience less than snappy – particularly if you're used to a decent smartphone – and you'll struggle to run more intensive apps. Older and more basic games might be an option, but demanding titles such as *Apex Legends*, *Genshin Impact* and *Diablo Immortal* won't be, at least at anything beyond the lowest detail settings.

The more you pay, the more processing power and RAM you'll have at your disposal. Android tablets will go from mid-range chipsets to the high-end, while the iPad range starts with the speedy A13 Bionic in the ninth generation iPad and goes all the way up to the M1 and M2 – the exact same chips you'll find in recent MacBooks and macOS PCs. There's no real point in going too high if you're not going to use that kind of performance – it's wasted on a consumption device – but if you're thinking of using a tablet as your main device or as a secondary computer, then your applications will run more smoothly with more power at their disposal.

Below: You don't need an abundance of processing power for reading ebooks.



3 Can you skimp on the screen?

No. There are some areas where you can make compromises to get a cheaper tablet, but it's not worth penny-pinching here. For one thing, resolution matters on a device that you'll use at less than a bent arm's length away. Some of the 800 x 1,280 screens on smaller tablets can be usable, but at 11in even a Full HD (1,920 x 1,080) screen can look fuzzy or pixellated, and a higher-resolution screen will be noticeably sharper.

That said, resolution isn't the only factor. Brightness and contrast arguably make even more of a difference, especially if you're streaming TV shows and movies. Some tablet screens even support HDR and HDR standards such as Dolby Vision. Colour reproduction is also crucial, particularly if you use your tablet for creative purposes.

One final gotcha. Be aware that, even if your tablet has a Full HD or higher resolution, it might not be able to stream Full HD video from many streaming services unless it has the Widevine DRM certification to do so. Check the specs carefully, and you'll see some tablets listed as Widevine L3 certified and others as Widevine L1. Widevine L3, which uses software for DRM management, will see you stuck at SD resolutions in Netflix or Amazon Prime. All the tablets on test support Widevine L1.

4 How about audio?

On a smartphone, the speakers aren't that important; if you're planning on watching or playing something, headphones will beat the

Left: Ensure your tablet has the correct Widevine spec for watching Full HD content.

built-in sound any day. It's different on a tablet, where decent speakers working in stereo make using them more likely, at least around the home.

It helps, then, to have a solid set of speakers, but don't get too caught up in the idea of built-in Dolby Atmos audio or other forms of processed surround sound. There's only so much you can do even with two to four speakers.

5 What other hardware features do I need?

Physical connectivity can be much of a muchness. USB-C is now supported across all but the most budget tablets, though it may be limited to USB 2 or USB 3.2 Gen 1 speeds on cheaper devices. Those standards translate into peak transfer rates of 480Mbits/sec and 5Gbits/sec respectively, compared to the 10Gbits/sec speeds of USB 3.2 Gen 2 and 40Gbits/sec of USB 4 and Thunderbolt 4.

Above: Many tablets come with useful extras such as pens and keyboards.

Even so, it's hard to care as we so rarely transfer files to and from tablets by wire. Instead, focus on wireless connectivity. Bluetooth 5 and Wi-Fi 5 are now the bare minimum you can expect, but some mid-range and high-end tablets now pack Wi-Fi 6 or even Wi-Fi 6E. These will give you better speeds and a more reliable connection if and when you connect to a Wi-Fi 6 or Wi-Fi 6E router.

As for storage, if you're looking to install a lot of apps and games then you really need more than the base-level 64GB option. True, you can stream media and run apps from a microSD card on some devices, but performance may suffer with your apps, depending on the card. Having more to start with is often a wise investment, if you can afford it.

Finally, cameras. A good or bad rear camera might not sway things either way, but a good front camera is a must if you're planning to use your tablet for video chats or conferencing.

6 How about software?

Apple's iPad OS is still the gold standard for tablet operating systems, and has evolved to cover more creative and productivity scenarios with features such as multitasking, support for external displays and the new Stage Manager (this organises files and apps to make life more clutter-free). App support is fantastic, with most major apps designed to take advantage of larger screens and multitasking, or available in versions designed specifically for tablets.

By contrast, Android is patchy. Manufacturers such as Samsung, Huawei and Lenovo have designed enhanced UIs with stronger tablet-centric features, but app support remains comparatively slim, while Amazon's Fire OS – a fork of Android – is more aimed at media consumption than serious creative or productivity applications.

Updates are another key issue. Apple supports new iPads with upgrades for roughly five years – and often more – while Amazon supports Fire OS tablets with at least four years of security updates, though full software updates aren't guaranteed.

With Android, it depends on the manufacturer and tablet. You may be looking at just one major update and a couple of years of security updates, or this might extend to four years of updates with, say, Samsung's Galaxy Tab S devices.

This, together with the excellent hardware, is one reason why Apple's iPads hold their value better than Android and Kindle Fire tablets.

7 What about the extras?

With manufacturers following in the footsteps of Apple and Samsung, tablets are often supported by an ecosystem of first- and third-party accessories, including keyboards, cases, covers and pens. Factor these into your decision and your budget if you plan to use your tablet for productivity or creativity purposes, while a pen can be useful just for taking notes.

HOW WE TEST

We put our tablets through a barrage of cross-platform benchmarks, including Geekbench 5, the WebXPRT 4 browser workload benchmark and 3DMark's Wild Life Extreme, Wild Life and Slingshot mobile 3D graphics tests. We also test screens with a colorimeter, with an emphasis on colour coverage and brightness.

To test each tablet's battery life, we run a video-rundown test with a 1080p file and the brightness of the displays set to a uniform 170cd/m2 (with Wi-Fi on). We then test how much charge can be recovered from 30 minutes connected to the mains. We also use each tablet for a mix of web browsing, video streaming, office work and gaming, to see how they measure up in real-world use.

APPLE IPAD (10TH GENERATION)

A great update with tangible improvements, but it's dragged down by a premium price.

★★★★☆

Price 64GB, $719 | from apple.com/au

It's too much to call the 2022 iPad a reinvention, but it's certainly a modernisation. Out go all the design elements we've had for over a decade – the chunky bezels, the Home button, the Lightning port – and in come familiar features previously reserved for the iPad Pro and iPad Air, with a slimmer, flat-edged design, an edge-to-edge display, a Touch ID power button and a USB-C port on the bottom edge. Better still, like so many of Apple's best-loved devices, it comes in a range of colours.

Like the iPad Air, the new iPad feels good in the hand. It's roughly the same size and just under 1mm thicker, while weighing only 16g more. As with the Air there are still fairly sizeable black bezels, but nothing to seriously distract you from the screen. This isn't as good as the screen on the iPad Air. It doesn't hold up as well in bright sunlight, even though we measured the maximum brightness at a respectable 504cd/m2, and where the Air covers 80 percent of the DCI-P3 spectrum, the iPad reaches only 72 percent.

This isn't a serious problem; the screen still covers 100 pecent of the less demanding sRGB spectrum and, in normal lighting, it's great for streaming Netflix and Disney+ (or playing games), helped by the excellent stereo speakers. These are as loud and clear as you could hope for.

Like the previous iPad, the 10th gen model supports the Apple Pencil. Unfortunately, it's the same Apple Pencil, namely the first-gen stylus with a Lightning port. It's still one of the best styluses around, capable of tracking tiny movements and handling nuance when you're drawing, but to charge it you'll need the Lightning to USB-C adapter Apple now bundles with the Pencil.

It makes you wonder why the new iPad doesn't simply support the superior Pencil 2, but the answer is surely to leave some clear water between the plain iPad and the Air. However, at least this iPad gets its own folio-style Magic Keyboard. It doesn't have the Air Magic Keyboard's ingenious floating design, but it's stable and the keyboard has plenty of travel, along with some nice tactile feedback.

Large black bezels surround the screen, but aren't too much of a distraction.

Connectivity is basic. While it charges via USB-C, the port only supports USB 2 data transfer speeds, which is the kind of thing we expect from budget tablets. You can still connect to an external display, but only at a maximum 30Hz at 4K. However, you do get Wi-Fi 6 and Bluetooth 5.2 support.

Apple has upgraded the 8MP rear camera to a new 12MP module. This produces fine results in most lighting, but grain increases in dimmer conditions. Better still, the 12MP front-facing camera has been moved to a position on the long edge, which is exactly where you want it for video calls and meetings. It's sharp, with good control over exposure, so you won't have any complaints there.

The iPad is compatible with the folio-style Magic Keyboard.

Apple reserves its flagship M-series chips for the higher-end iPads, but the A14 Bionic in the new iPad still puts the processors in most Android tablets to shame. Its scores in Geekbench put it towards the top of the table, above the Samsung Galaxy Tab S8 and S8 Ultra, and it's a similar story with WebXPRT 4 and our 3D benchmarks. If you're in the market for a gaming tablet and can't stretch to the iPad Air, we'd point you to the iPad or the mini every time.

As for battery life, Apple promises around ten hours and in our rundown tests we comfortably exceeded that. What's more, the bundled 20W charger can get you back to 26 percent from zero in 30 minutes.

The biggest issue facing the new iPad is its price. At around $720 for the base model, the outgoing iPad was easy to recommend. Any serious Android competitors tended to be either underpowered or more expensive, and the strength of Apple's ecosystem helped make up for any shortcomings. This iPad is no longer a budget option; it's going up against high-quality tablets from Samsung and Lenovo that beat it on features and screen quality.

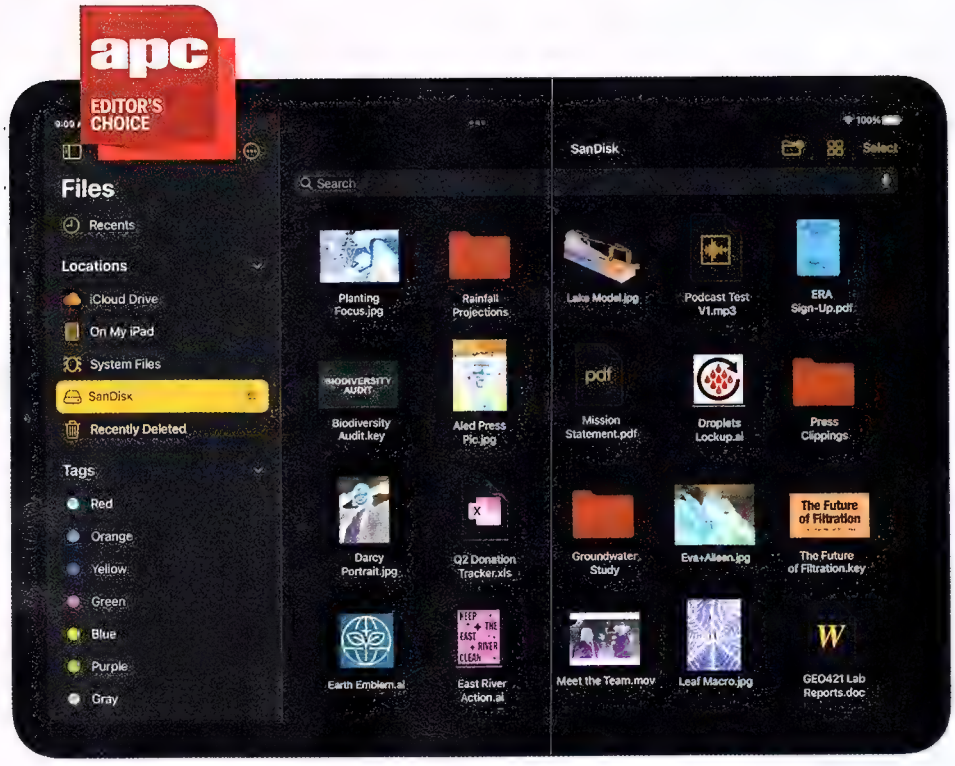
The iPad's advantages – speed and software – still make it worthy of your consideration, but it's no longer the slam-dunk tablet that everyone should buy.

APPLE IPAD AIR (5TH GENERATION)

The ideal balance of features, software, performance and price means the Air floats to the top of the tablet pile.

★★★★★

64GB, $997 | from apple.com/au



The 5th generation iPad Air isn't necessarily the best tablet in this Labs – or even the best iPad – but it's the best tablet overall for most people to buy. On the one hand, it has many of the key strengths of the iPad Pro: class-leading performance, an excellent screen and accessories that can transform it into a productivity or creative powerhouse. On the other hand, it won't cost you a small fortune.

The Air's design hasn't evolved much since the 2020 4th generation model, but then it didn't really need to. Describing it as all-screen is pushing it – there's a fairly chunky bezel on all four sides – but it's a clean look that minimises bulk to put the focus on the display. Like the new iPad, it also comes in a range of colours, with pink, purple and blue on top of starlight and space grey.

The power and volume buttons are arranged (when held in portrait mode) around the top-right corner, with the former doubling as a TouchID sensor, while there's a USB-C port on the bottom edge. This supports 10Gbits/sec connectivity through USB 3.2 Gen 2. As for wireless, the Air has Wi-Fi 6 (though not 6E) and Bluetooth 5, so it's well placed for high-speed links to the latest kit.

Apple now offers Pencil and keyboard support across the iPad range with the exception of the keyboard-less iPad mini, but the Air does better than the new 10th gen iPad by working with the Pencil 2 and the 11in Magic Keyboard. The latter converts the Air into a workable small-screen laptop, particularly with iPadOS's enhancements for multitasking and split-screen views. The setup with the keyboard on the desk or lap and the tablet itself nearly levitating on a hinged magnetic plate feels surprisingly stable and comfortable, while the typing action is tight and responsive. It's hard to call the Air a serious laptop replacement, but a secondary device for travel? Definitely.

It helps that the screen is great, albeit not as spectacularly great as the screen on the iPad Pro. Brightness can hit over 500cd/m2 with the adaptive brightness setting turned off (it's closer to 440cd/m2 at the default setting), while gamut coverage sits at 96 percent sRGB and 80 percent DCI-P3. Colours are rich and the image clarity is hard to fault. Whether you're editing photos or bingeing Netflix, your eyes are in for a treat.

The bright screen produces rich colours and sharp images.

As for your ears, the iPad Air can't match the wide immersive soundscapes of some tablets on test, but the stereo output is crisp, detailed and well rounded, and easily good enough for background music or a movie marathon.

When it comes to performance, there really isn't much that the iPad Air can't do. With the same M1 processor as the previous-generation iPad Pro, it ripped through our benchmarks without any serious resistance. From Geekbench through to 3D benchmarks, no Android slate gives it any real competition, with only the 2022 iPad Pro out in front. Whether you're planning to play games, create multi-layered illustrations or put videos together on the move, you're unlikely to come up against the Air's limitations. In fact, the only thing holding you back would be storage: the 64GB of the base model won't cover a huge range of apps and data, making the 256GB version look more future-proof.

Attach the 11in Magic Keyboard to the Air and it feels stable and comfortable.

Battery life isn't quite so impressive. You can squeeze around ten hours of life from a charge under light usage with brightness set to halfway, but the iPad ran out of puff in 9hrs 20mins in our HD video-rundown test. On the plus side, you can get back up to 25 percent in half an hour from the bundled 20W compact charger, or reach 34 percent if you have a 30W charger handy.

The iPad Air isn't a cheap tablet by any means, but it's a convincing alternative to the iPad Pro and at a price that's easier to swallow. What's more, you still get access to the best line-up of tablet apps and games and the power to cruise through all of them. Hitting the sweet spot between features, performance, size and price, it's a fantastic buy.

APPLE IPAD PRO 12.9 (5TH GENERATION)

The ultimate big-screen tablet, if you're prepared to pay the big price – and don't forget the accessories.

★★★★★

128GB, $1,899 | from apple.com/au

apc EDITOR'S CHOICE

The tablet that defined the whole "Pro" category is back, much the same as 2021's version but with the addition of the new M2 chip. The result is one of the best – and certainly the fastest – tablets ever made, albeit one that's going to be too big, too expensive and possibly too powerful for all bar the most demanding.

There's no doubt about the M2's performance. The iPad Pro's Geekbench 5 scores are so far ahead of most other tablets on test that it's ridiculous, and it's comfortably faster than the M1-bearing iPad Air as well. It's the same story in the WebXPRT 4 benchmark, while it's leagues ahead of all other tablets in 3D benchmarks such as Wild Life Extreme. You're not just buying great performance and smooth frame rates now, but a tablet that will still be a speed demon in five years.

The XDR screen, complete with adaptive refresh rates of up to 120Hz for a silky feel whether you're navigating iPadOS or playing a game, is once again a star feature. It's broadly similar to last year's iPad Pro, using local dimming zones to deliver the kind of deep blacks and vivid highs that are usually reserved for OLED panels.

This means it can produce a high-contrast HDR image when required, with obvious examples being when watching Dolby Vision HDR video or firing up an image in Affinity Photo. Portions of the screen can hit over 1,500cd/m2 in HDR mode. Even SDR brightness levels can reach 586cd/m2, so you'll never complain of a dark screen.

The display covers 100 percent of sRGB and 82 percent of DCI-P3, and colour accuracy is phenomenally good, with an average Delta E of under 0.4. This is a screen you can trust for colour-critical image editing, which is yet another reason for its Pro moniker. And when you do want to relax, the four built-in speakers can put out a warm and punchy sound to match.

The spec remains top-notch elsewhere. You have dual 12MP cameras front and rear, capable of capturing excellent stills and video. The iPad Pro is also the first tablet we've seen with Wi-Fi 6E on board, not to mention 40Gbits/sec transfers over either Thunderbolt 4 or USB 4 (both use the USB-C port). You can drive external displays of up to 6K resolutions at a comfortable 60Hz, and it's never been easier or more useful to do so, thanks to iPadOS 16 (see p89).

The superb XDR screen is as close to perfection as you'll get on a modern tablet.

To make the most of the iPad Pro you'll need accessories, particularly the excellent Magic Keyboard and Apple Pencil 2. Buying both will increase the price substantially: the Pencil costs $219, the keyboard a further $299. And this is already an expensive device. The $1,899 price at the top of this review is for the base 128GB version, and it's hard not to be tempted to upgrade to 256GB for an extra $180. And if you want 5G, that's another $250.

The Magic Keyboard adds functionality, but it comes at a

At this point, we need to mention that the 12.9in version of the iPad Pro has a significant 11in sibling. This starts at $1,399, and while we haven't tested it (Apple is always much keener to send in the 12.9in version), we know that it matches the 12.9in version for specification so we would expect near-identical performance in our tests. Clearly, you lose out on screen size, but with a $500 difference in the price it's one obvious way to save some cash. "Save" being a relative term here.

Even so, we would lean towards the 12.9in Pro for true power users. No other tablet feels this close to working as a high-performance computer that could cover all your business needs, and part of the reason for this is the significantly larger screen. Perhaps its more obvious rival is the fourth generation of the iPad Pro 12.9, as in truth there isn't a huge gulf in class between this year's release and last year's. And while the 2021 edition isn't as easy to get hold of (Apple no longer sells it directly), it's more competitively priced.

HUAWEI MATEPAD 11 (2022)

Fantastic hardware, with a bundled keyboard and stylus, but it's not quite there on the software front.

★★★★☆

$949 | from consumer.huawei.com

The bright screen has a refresh rate of 120Hz and is a real highlight.

Huawei remains a stalwart of the tablet scene, despite the fact that Google was forced to cut it off from using its full suite of Android services back in the pre-Covid era. This means that using the latest version of the Huawei MatePad 11 still involves making a series of accommodations: to Huawei's Harmony OS 2.0 operating system, to its AppGallery app store, and to doing without Google Play, the Chrome browser, Google's native apps and other Google services. This may or may not be an instant deal breaker.

If it is, that's a shame: the MatePad 11 is a well-designed tablet with a high specification at a very reasonable price. It's sold bundled with a stylus and keyboard case, and you're getting an 11in screen, high-end Qualcomm processor, 6GB of RAM and 128GB of storage.

There's much to like about the MatePad's design. The black metallic case is slim at just 7.3mm, and easy to hold single-handed at 485g. The minimal bezels and fuss-free styling give it a nice, understated look. You don't get a fingerprint reader, but Huawei has implemented a facial recognition system that's speedy and accurate, if not as secure as the more advanced 3D systems. The keyboard cover clamps on to the rear of the tablet magnetically, and connects through Bluetooth, transforming the MatePad 11 into an effective mini-laptop.

There's no physical connection for the keyboard, but the moment you slip it onto the case it pairs and starts charging. We have no complaints about Wi-Fi 6 (Wi-Fi 6E would be even better, but that's too much to expect at this price), and it seems similarly churlish to complain about a USB-C connection that supports USB 3.2 Gen 1 at 5Gbits/sec rather than the 10Gbits/sec or higher we see elsewhere.

But the best aspect of the MatePad 11 is its screen. Not only do you get a 2,560 x 1,600 resolution but a 120Hz refresh rate, while the display itself is bright with punchy colours and respectable levels of contrast. The frame rate makes for a silky-smooth experience while navigating the UI and browsing, to the extent that it's hard to go back to other tablets with the basic 60Hz refresh.

To see this display at its best, we'd recommend switching to the Vivid setting. We saw brightness bump up from 468cd/m2 to 472cd/m2 and the sRGB gamut coverage jump from 82% to 97%, although colour accuracy suffered with the average Delta E rising from 1.45 to 3. Still, that's a compromise we'd be willing to make for a better experience streaming movies and the latest TV shows.

Despite the slim frame, the sound is impressively clear, with excellent steering of dialogue and effects in a pseudo-surround soundstage. There's even a bit of depth and dynamic range to bring action-heavy movies and shows to life.

The bundled stylus and keyboard make the MatePad especially good value.

If you'd rather play games, the MatePad's Qualcomm Snapdragon 865 processor will happily do the job. It's not as fast as the Snapdragon 870 in the Lenovo P12 Pro, let alone the A15 and M1 processors in the iPads, but you can still play most games at high settings without watching the frame rate crater. It's good in creative and productivity apps as well, with Geekbench scores that put it neck and neck with the P12 Pro; the Huawei was a fraction slower in the single-core tests, but faster in the multicore test.

As for battery life, the MatePad 11 nearly matches the P12 Pro by holding up for 13hrs 25mins in our 1080p video-rundown test. It supports up to 22.5W charging, reaching 27 percent in 30 minutes from a cold start.

The make or break with this one is leaving Android behind for Harmony OS. There's nothing much wrong with the OS or its UI – it's not a million miles away from Android and is colourful and easy to navigate, while it supports a good range of Android apps and native apps. However, to install many you'll need to use AppGallery to find and effectively sideload them. It's easy enough, but still far from seamless, and you might not trust all the sources found. There's also no way to pay for apps or add-on content.

For some users this won't be a concern; Harmony OS and AppGallery is an improvement on Huawei's previous Google-hobbled Android implementation, and it's hard to fault the MatePad 11 on the hardware side. Yet Huawei still has a lot of work to do if it wants to build an ecosystem to rival iPadOS or even Android.

LENOVO TAB P12 PRO

A lovely screen and high-end features in a cost-conscious package make the Tab P12 Pro a great choice.

★★★★★

128GB, $449 | from lenovo.com/au

apc EDITOR'S CHOICE

The huge 12.6in AMOLED display produces stunning images.

While Apple has been selling the 12.9in iPad Pro since 2015, the Android tablet manufacturers have largely shied away from such large-format devices. Now, buoyed by the acclaim for its Tab P11 Pro, Lenovo is entering the ring with a 12.6in version. The P12 Pro doesn't get everything right, but it's a formidable big-screen slate.

It's big, but surprisingly not that heavy. With a tough but slim alloy shell under 6mm thick, plus understated 6mm bezels, it's a manageable 565g in weight and well balanced for handheld use or propping up on a lap or knee. There's a single USB-C port on the right-hand side for charging, which supports USB 3.2 Gen 2 for 10Gbits/sec connectivity. On the left-hand side, right at the top corner, there's an inset power button with a built-in fingerprint reader, which worked flawlessly during testing. On the rear you'll find a magnetic charging point for the bundled Precision Pen 3 stylus, which clamps on securely while it's not in use.

But the P12 Pro is all about the screen. It's a 12.6in AMOLED display with a 2,560 x 1,600 resolution and the image quality is nothing short of beautiful. It doesn't actually go overly bright under normal conditions; we measured the maximum brightness at 404cd/m2, though with auto-brightness engaged and some sunlight it will hit 600cd/m2. Thanks to the perfect blacks, contrast is effectively infinite, while the screen covers 100 percent of both the sRGB gamut and DCI-P3. Colour accuracy is good rather than stellar, with an average Delta E of 2.9, but still fine for anything bar colour-critical photo and video-editing. For more casual work – and for streaming video and playing games – it's superb.

This helps make the P12 Pro a brilliant tablet for entertainment, and it helps that the slender case also encloses a decent quad-speaker system. There isn't a huge amount of bass and the sound at higher volumes can be brash, but at lower levels you get a surprisingly immersive way to binge the latest hits on Netflix or Disney+. Load up *Call of Duty: Mobile* or *Diablo Immortal*, and you have a strong mobile gaming platform – and an even better one for Xbox cloud streaming, despite the limited 1080p resolution of Microsoft's service. The only worry you might have there is that the onscreen controls can involve huge areas of the screen, making it hard sometimes to move and aim quickly in fast-paced action games.

Lenovo manufacturers a keyboard case for the P12 Pro, and while it wasn't available at the time of testing, we understand that it's roughly the same as the one for the P11 Pro, only scaled up. We were able to test the Precision Pen 3 stylus, however, and while it can't match the smooth, lag-free action of the Apple Pencil or Samsung Galaxy Tab S8 styluses, it's still accurate and responsive.

The P12 Pro supports the same productivity software enhancements as the P11 Pro, including a more Windows-like desktop experience with floating windows and a taskbar at the bottom of the screen.

With the bigger tablet comes a step up in performance, thanks to Qualcomm's Snapdragon 870 processor, with one high-performance Kryo 585 Prime core, three speedy Kryo 585 Gold cores and four energy-efficient Kryo 585 Silver cores running at between 1.8GHz and 3.2GHz. It's no longer the fastest processor in Qualcomm's lineup, but it's good by Android tablet standards. Were it not for Samsung's superpowered Galaxy Tab S8 tablets, the P12 Pro would have been the fastest Android slate on test.

We didn't have high expectations of the P12 Pro's battery life, but in the end our expectations were confounded. The P12 Pro kept on running through 13hrs 39mins of Full HD video playback, making this one area where it can take on Apple's finest and come out on top.

It's tempting to see the P12 Pro as a second-fiddle tablet, not quite matching the performance and quality of Apple's or Samsung's high-end slates. Yet pause and see how much you're getting for your money. It has a massive, high-quality screen, ample performance, good sound, a bundled stylus and the flexibility to transform into a laptop should you need it. It's cheaper than the Samsung and Apple equivalents, without feeling in any way like a less capable device. And that's why it walks away with an Editor's Choice award.

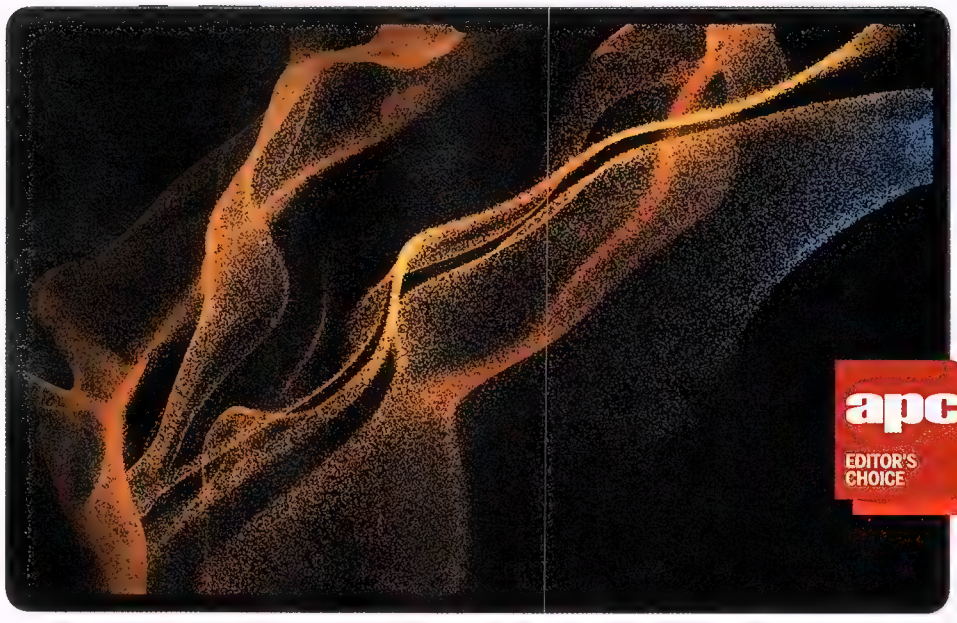
The Precision Pen Stylus is accurate and responsive.

SAMSUNG GALAXY TAB S8 ULTRA

Beautiful, fast and vast, this is a remarkable – in the truest sense – big-screen Android tablet.

★★★★★

128GB, $1,799 | from samsung.com/au



The 120Hz Super AMOLED panel is a thing of beauty.

If you think the 12.9in Apple iPad Pro and the Lenovo Tab P12 Pro are enormous, you haven't seen anything yet. The Samsung Galaxy Tab S8 Ultra takes the prize as the biggest mainstream tablet of the moment, with a whopping 14.6in screen that gives it a similar footprint to a slimline 14in laptop. It's almost comically massive. Use it on the train or on your next flight and you'll soon become used to people's stares and smirks.

Of course, that size also has its pluses. For a start, there's ample space for multitasking, or for working inside complex image or video-editing apps. Streamed movies and TV shows look spectacular; you might actually prefer it to your TV set. Most importantly, put the Tab S8 Ultra inside Samsung's Tablet Case & Keyboard and the tablet can switch to Samsung's DeX environment and give you something very close to a conventional laptop experience, complete with floating windows and proper multitasking features. Samsung has been working on this stuff for a while now, and it's streets ahead of the Android competition and, in some respects, Apple too.

One thing Samsung does bundle in is its S-Pen stylus, even providing a space in the rear of the tablet where it fits, holding on magnetically and charging while in situ. It's another mature piece of tech, and Samsung supports it with good note-taking and sketching apps.

The screen itself is a thing of beauty. Based on Super AMOLED technology, it can reach a peak brightness of over 580cd/m2 with SDR content and go even higher in HDR. And, thanks to AMOLED's deep blacks, contrast is unbeatable. Colour accuracy is also close to faultless, and the wide-gamut screen spreads even further than the DCI-P3 space (55 percent further, to be precise). Whether you use the default Vivid setting or the more colour accurate Natural, any app you use or any content that you watch is going to look great. It runs at a 120Hz refresh rate as well, so you're assured that all your scrolling and zooming will be as smooth and wobble-free as you like.

This is a top-notch tablet in just about all other respects. It supports Wi-Fi 6E, along with 5G if you buy the cellular version, and charges over a USB-C connection that supports up to 45W charging. Battery life is impressive, too, with the Tab S8 Ultra lasting 12hrs 35mins in our rundown tests. Plug in a 45W charger, and you can have 40 percent of your charge back in half an hour. It would have been nice to have USB 3.2 Gen 2 or even USB 4 connectivity, but we'll cope with the 5Gbits/sec of USB 3.2 Gen 1.

Thanks to the Snapdragon 8 Gen 1 chipset, the Tab S8 Ultra puts in the best performance of any Android tablet in the Labs. From Geekbench through to the WebXPRT browser benchmark, it scored impressive results that put it near the top of the table. It's a good option for 3D gaming, too, though you'll struggle with that big screen for any games where a controller isn't an option. The only issue is that it can't compete with the desktop-class performance of the M1 and M2 processors in the Apple iPad Air and iPad Pro. If the Snapdragon 8 Gen 1 is in a different league to the chipsets found in other Android tablets, then the M1 and M2 are playing at a higher level still.

The iPads have other advantages in their more comprehensive software support, but strong tablet-optimised apps are beginning to emerge on Android, and there's hope that, between Android 12L and the push around Google's upcoming Pixel Tablet, more will arrive. If so, the Tab S8 Ultra's already strong position will only become stronger. It's big with a price tag to match, but also a brilliant device.

The Tablet Case & Keyboard turns the Tab S8 Ultra into a conventional laptop.

AMAZON FIRE 7

A decent low-cost option, especially for family use, although the low-res screen holds it back.

★★★☆☆

16GB, $99 | from amazon.com.au

The Fire OS software is a little idiosyncratic.

Although it's $10 more expensive than the previous generation, this late 2022 update to the Amazon Fire 7 remains one of the cheapest tablets money can buy. In fact, it's the only tablet under $100 that you should even consider. What's more, Amazon justifies the extra cost with a few judicious upgrades.

The biggest are an upgraded processor – now a quad-core MediaTek running at 2GHz – and double the RAM, with 2GB as standard. The Fire 7 is still no-one's idea of a speedy tablet. Its Geekbench scores are almost painfully low, while its 3D performance is even worse; the 3DMark Wild Life and Wild Life Extreme tests won't even run, while frame rates elsewhere are only made tolerable by limited pixel-pushing demands of the 1,024 x 600 resolution screen.

The screen resolution is still the tablet's biggest failing – even at just seven inches, text looks pixellated, and pin-sharp clarity isn't on the cards. There's a visible lack of colour depth as well, with only 63 percent of the sRGB gamut covered and 45 percent of DCI-P3. Yet the screen goes fairly bright, at just over 400cd/m2, and contrast is mediocre rather than terrible. Sound is weak and rough on the ears at higher volumes, so you might want headphones either for quiet listening, or to keep out the racket when the kids are watching Peppa Pig at full volume.

The base model comes with just 16GB of storage, but you can double that to 32GB. Or you can slot in a microSD card for up to 512GB of space. As always, the cheapest versions come with ads on the lockscreen. You also need to be sure you can put up with the content-focused style of the Fire OS software, not to mention the limited and often dated app selection in Amazon's dedicated Appstore.

Battery life has improved since the last Fire 7; we saw just over 11 hours of HD video streaming before it ran out of charge. Charging itself isn't overly speedy, but it restored to 23 percent in 30 minutes.

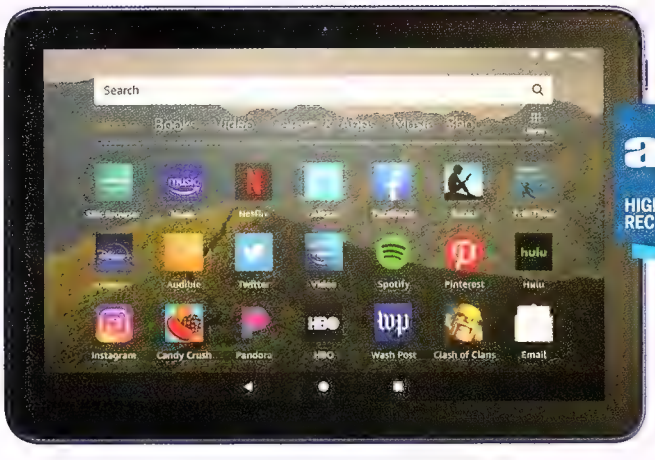
For all its faults, the Fire 7 feels cheap but rarely nasty. In fact, like its predecessors, it's built to take the kind of punishment that a tablet gets with younger kids around. It's far from the ultimate tablet, but it might be the ultimate survivor, especially with the optional Kid-Proof Case.

AMAZON FIRE HD 8

Plenty of rough edges, and not much firepower, but the Fire HD 8 offers serious small-screen value.

★★★★☆

1TB, $215 | seagate.com



The screen is good for the price.

The Fire HD 8 is a real step up from the smaller Fire 7, not just in terms of size but in almost every way. You get a better class of IPS screen with a higher 1,280 x 800 resolution, so still not Full HD but a tangible improvement. There's more number-crunching power, too, with an 8-core MediaTek CPU accompanied by 3GB of RAM. You also enjoy double the storage, with 32GB on the base version and 64GB on the higher-end model.

While all this comes at a correspondingly higher price, you're still getting better value. Within its limitations, the Fire HD 8 is just a nicer device to use.

It helps that the screen is brighter than its smaller sibling's, peaking at 492cd/m2 in our tests, with a punchy contrast of 1,550:1. Colours still look dull when compared to tablets such as the iPad mini, but gamut coverage of 83 percent in sRGB and 61 percent in DCI-P3 are good for the price. It works perfectly well for casual browsing and streaming.

Sound quality is also an improvement over the Fire 7, with more depth and a wider stereo spread, though it can sound harsh and congested if you push up the volume.

Performance is significantly better than the Fire 7, particularly in Geekbench's multicore tests and the WebXPRT browser benchmark. However, 3D performance is still underwhelming, with the Fire HD 8 lacking the horsepower to handle the 3D Mark Wild Life tests (it managed 1,225 in 3DMark's easier Slingshot test to the Fire 7's 686). Stick to less demanding games.

One thing this tablet has in spades is stamina. We left it streaming HD video, and it was still up and running nearly 18 hours later, eclipsing any other tablet in this test. Charging up takes a long time – we only reached 17 percent with a 30-minute charge – but it's unlikely to be a daily chore.

This is still a budget tablet, and not as fast as the Nokia T10, let alone the iPad mini. You still have to be comfortable within Amazon's rather limited app ecosystem. But if you're realistic about this, then the Fire HD 8 has a lot to offer for a small amount of cash.

APPLE IPAD MINI (6TH GENERATION)

The best small-screen tablet out there, but other iPads offer superior value for money.

★★★★☆

64GB, $827 | from apple.com/au

The screen is a real highlight.

Sure, it's now over a year old, but the iPad mini is ageing well. It's effectively a miniature version of the last-generation iPad Air, packing a six-core A15 Bionic processor and 4GB of RAM into a device with an 8.3in screen. It's the perfect size for a small-screen iPad; big enough for web browsing, video streaming, gaming and even image-editing or note-taking apps, but small and light enough that you can hold it single-handed with ease. You'll barely notice it inside a bag.

The screen itself is significantly better than anything you'll find on the cheaper 8in tablets. Thanks to its 2,266 x 1,488 "Retina" resolution, it looks pin sharp. Peak brightness is actually just above the stated 500cd/m2, while contrast levels and colour reproduction are superb. The sound is also impressive by small tablet standards; watch movies and the score, effects and dialogue have a weight and stereo imaging you just won't find on any rival.

That higher price also buys you luxuries such as a Touch ID sensor, Wi-Fi 6 connectivity and a pair of 12MP cameras you might actually want to use to shoot photos or videos. Most importantly, it buys you performance. While the A15 Bionic is clocked down from the identical chipset found in the iPhone 13 series and 4th generation iPad Air, this tablet's benchmark results remain stellar in both 2D and 3D tests. You can comfortably run more demanding apps and play the latest Apple Arcade games, while there's plenty of headroom for titles such as *Fortnite* or *Call of Duty: Mobile*. Put the screen size aside, and there's little that the baby iPad can't tackle.

Nor does battery life suffer: we comfortably exceeded ten hours in our video-rundown tests. Recharge, and you can get back up to 32 percent within half an hour.

There's no doubt, then, that this is the best small-screen tablet you can buy today. However, it also starts at nearly $830 with Apple's current pricing, making it four to five times more expensive than the competition. Given its all-round excellence, it's still good value, but if you're happy with a larger tablet, other iPads are better value still.

iPadOS 16: what's new

A quick rundown of the recent additions, including Stage Manager.

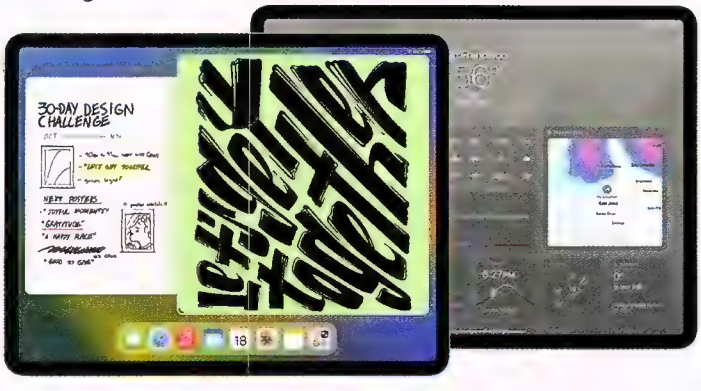
All the iPads now run iPadOS 16, with the biggest change being the introduction of Stage Manager. It's an optional feature that has to be activated from the Settings | Home Screen & Multitasking menu, so why should you be tempted?

On the iPad mini you may not be, as it works best with a big screen. The idea is to bring something closer to the windowed multitasking of macOS to iPadOS, where apps aren't as locked in position and size as they are in the Split View and Slide Over options. Apps can live in windows that overlap and be resized – though only to certain sizes, based on an invisible snapping grid.

It's an interesting idea, but it's not yet perfect. Sometimes it crashes or causes unexpected effects in apps, and it's fiddly: you might open an app and find that it appears in a small window on a screen with nothing else on – resizing it to fill the screen just feels like an unnecessary extra step. There's a shortcut to do this with two taps, but if you don't know to look for the dots at the top of a window, you'd have to drag using the control on the bottom corner, which is slow.

Outside of that, iPadOS 16 adds some great smaller features. The ability to send scheduled messages in the Mail app is massively welcome, as is the Weather app (and accompanying weather widgets selection). The ability to edit and unsend iMessages can also be really useful if you use the platform professionally, as well as personally.

Beyond all these, iPadOS continues to be an interesting mix of excellence in many ways, and frustration in others. Its app support is far beyond the competition, in terms of delivering apps that are both powerful as well as being usable with touch, and designed specifically for the space that the tablet screen gives you.



Stage Manager brings improved multitasking to iOS 16.

And iPadOS is still as slick and reliable as ever, aside from Stage Manager's foibles. The integration with Apple's services and its other devices is excellent, thanks to old familiars such as Handoff (to move a task you're in the middle of between your iPhone, iPad or Mac) and Sidecar (which enables your iPad to be a second display for your Mac, with touch controls).

LENOVO TAB P11 PRO

A premium tablet at a mid-range price, there's much to like about the P12 Pro's smaller brother.

★★★★★

256GB, $597 | from lenovo.com/au

The 11.2in screen offers superb contrast levels.

When it launched in 2021, the P11 Pro became one of the most desirable Android tablets, thanks to a fantastic OLED screen and an optional keyboard that – with the aid of software – could transform the tablet into an effective laptop. The second-generation model is even better, addressing some of the minor issues of the first-gen tablet.

The 11.2in screen is encased in a tough metallic shell with a two-tone dark grey finish. It looks great as is, but you'll also want the Keyboard Pack. This includes a kickstand panel that attaches magnetically to the rear, with the stand folding out to support the screen, plus a keyboard cover that clamps on to the base of the tablet and its pogo pin connectors. It's a portable and practical solution, and while the keyboard isn't quite ThinkPad quality, the action is good enough for you to forget you're working on a convertible.

The screen is another highlight. It's bright – we measured the maximum luminance at 473cd/m2 – and with jet-black blacks the contrast is sensational. Throw in 100 percent coverage of both sRGB and DCI-P3, and you have one of the best displays for watching video on test. It's not quite as stellar in terms of colour accuracy, but only by the standards of tablets costing far more.

The original P11 Pro was restricted to Wi-Fi 5, but the new model switches up to Wi-Fi 6. Meanwhile, storage doubles from 128GB to 256GB, while the processor has been upgraded from the Qualcomm Snapdragon 730G to MediaTek's newer Kompanio K1300T. As a result, this proved one of the fastest Android tablets on test, and one you can trust to perform well in anything from creative apps to 3D gaming. You also get over 12 hours of battery life, along with 20W fast charging to get you back up to 25 percent in half an hour from a standing start.

Take the sub-$600 price into account and you arguably have the best-value high-end tablet and a worthy rival to the Galaxy Tab S8. The only reason not to buy it is that its sibling, the Tab P12 Pro, is even better, but if $600 or 11.3in is your limit, the P11 Pro is highly recommended.

NOKIA T10

A Fire HD 8 rival without the Amazon constraints – well worth considering if you're on a tight budget.

★★★★☆

32GB, $272 | from nokia.com

The T10 is fine for streaming videos and playing games.

Nokia's latest entry in the small-screen tablet market gives you a slightly higher spec than the Amazon Fire HD 8 but at a correspondingly higher price point, much like the Samsung Galaxy Tab A7 Lite and Lenovo Tab M8 have before.

To its credit, the T10 doesn't look or feel like a bargain-basement slate. The body is plastic but feels robust, with a fetching metallic-blue textured finish. With its rounded corners and 375g weight, it's comfortable to hold and use over long periods. In terms of features, though, it's basic. You get Wi-Fi 5 and an 8MP rear-facing camera and a 2MP front camera, neither of which are more than serviceable, but that's hardly unexpected at this price.

The screen has the same strengths and weaknesses as the Fire HD 8. The 1,280 x 800 resolution means that text and images look slightly blocky, while you won't get the kind of contrast and rich colours you'll see on higher-end tablets; sRGB coverage is just 80 percent and DCI-P3 59 percent. That said, the 446cd/m2 brightness level and a surface that deals well with reflections mean the screen works in most conditions, and it's actually a good little tablet for streaming video or playing games. You might want to plug some headphones in, though. The sound gets harsh beyond medium volume levels.

The T10 uses a Unisoc T606 chipset, as found in many cheap no-brand smartphones. With 3GB of RAM to play with it doesn't put on a bad show, outpacing the MediaTek processors in the two Amazon Fire tablets and even managing to run the more intensive 3DMark Wild Life tests. This isn't a fast tablet and it's still not suitable for demanding games, but apps launch quickly and navigation isn't glitchy.

Like its Amazon rival, the T10 is a battery life champion, lasting close to 18 hours in our rundown tests. For many people, it won't offer enough to justify the extra expense over the Fire HD 8, but it does have two major advantages. First, it runs a close-to-stock version of Android 12, with three years of updates promised. Second, that also means access to all Google services and the Google Play store. If that piques your interest, the T10 is a cracking low-cost device.

OPPO PAD AIR

Good design and some nice software tweaks, but the screen and performance reflect the price.

★★★☆☆

64GB, $379 | from oppostore.com

The screen isn't the brightest.

No prizes for guessing where Oppo's 10.4in tablet gets its inspiration from, but look beyond the surface and the Pad Air is a very different beast to the iPad Air. There's a lot to like about the Oppo tablet's exterior, from the dark metallic shell with 3D textured strip, to the slim sub-7mm thickness and light 440g weight. It's a very easy device to manage on the go.

From the screen to the core spec, however, we're back in budget tablet territory. The screen has what Oppo calls a 2K resolution, which translates into 2,000 x 1,200. Clarity isn't a problem, but it doesn't go particularly bright at 347cd/m2, and in direct comparison to more expensive tablets its colours are a little drab. That's despite strong coverage of both the sRGB and DCI-P3 gamuts, while colour accuracy isn't a problem. Yet it's too reflective to use in sunlight and you don't get the depth of colour or the vibrancy of the better tablet screens.

The compromises don't end there. You get Wi-Fi 5 rather than Wi-Fi 6, along with a 5MP camera at the front and an 8MP camera at the rear. Both are fine for casual snaps and web chats, but detail and exposure aren't brilliant. Most seriously, the Snapdragon 680 chipset – familiar from low-cost smartphones – isn't fast enough for intensive use. It's better than the MediaTek chipsets used in the Amazon Fire devices, in that it will actually run the 3D Mark Wild Life test, but it languishes towards the bottom of the benchmark tables.

On its smartphones, Oppo's ColorOS software is one of the better Android variants, and Oppo has implemented some useful tablet extras here: we're fans of the effective split-screen and sidebar views for multitasking, and the option to cast your smartphone screen to your tablet. Battery life is merely average, with nearly ten hours of 1080p video streaming from a single charge, and the same can be said of recharging speeds, going from zero to 23 percent after a 30-minute charge.

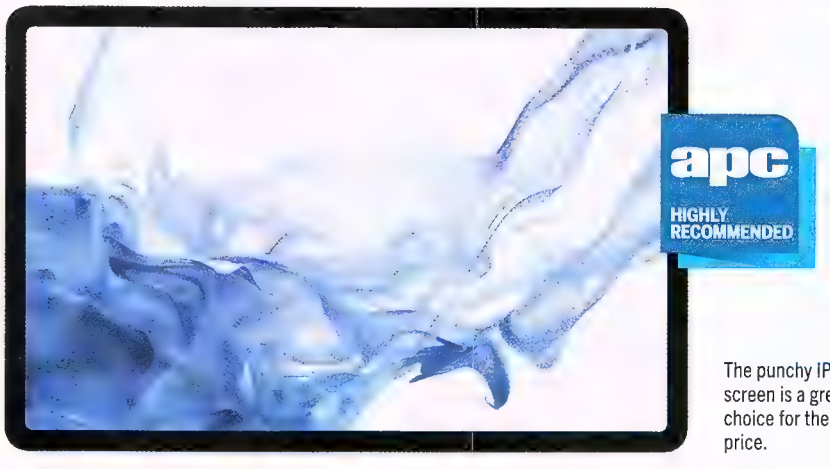
If it seems we're damning the Oppo Pad Air with faint praise, it's a decent buy for under $400. It's not fast and the screen could be brighter, but it could still work as a cheap browsing and streaming device.

SAMSUNG GALAXY TAB S8

A high-grade tablet with excellent performance and a bundled stylus, but don't ignore its cheaper rivals.

★★★★☆

128GB, $799 | from samsung.com/au



The punchy IPS screen is a great choice for the price.

Size isn't the only thing that differentiates the 11in Galaxy Tab S8 from the upscaled, 14in Tab S8 Ultra. Where Samsung's big beast rocks a beautiful AMOLED screen, the base Tab S8 model has an IPS display. You also miss out on Wi-Fi 6E – here just regular Wi-Fi 6 – and the RAM options of the high-end Ultra variants, with 8GB your only option.

None of this makes the Tab S8 a poor relation, despite its lower price. Taken on its merits, that IPS screen is very good. It can reach 480cd/m2, or 565cd/m2 with adaptive brightness on in sunlight. In the default Vivid mode it goes well beyond the sRGB gamut, even covering 19 percent more colours than DCI-P3, while there's no shortage of contrast. High-resolution images and video look great.

Samsung includes its S-Pen stylus, and it's ideal for sketches, digital art, annotating PDFs and taking notes, giving you a level of precision that simply isn't possible with a finger. And if you want to turn the Tab S8 into a pint-sized laptop, you can buy a keyboard case and switch to Samsung's DeX UI. The keyboard is a tad cramped, but it's still good for tackling urgent tasks on the move, and Samsung has had time to refine its multi-window enhancements.

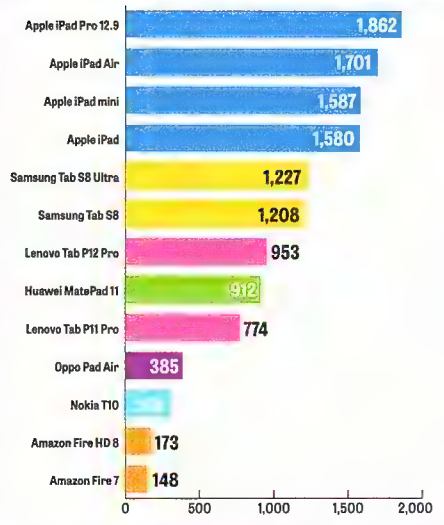
The goodies don't end there. Samsung's dual rear camera setup delivers better images and video than most tablets, while the 12MP front camera works well for web chats, with expert handling of focus and exposure.

Most importantly, you still get the same Qualcomm Snapdragon 8 Gen 1 processor; a very capable chip for both mainstream Android apps and 3D games. Like its bigger brother, the Tab S8 scored well in our benchmarks, with the twosome trampling the Android competition and only falling short of Apple's iPads. There's plenty of 3D horsepower for gaming purposes, and browsing is snappy. As for battery life, you can expect over 12 hours of video streaming, while the 45W charger can get you back to 45 percent within half an hour.

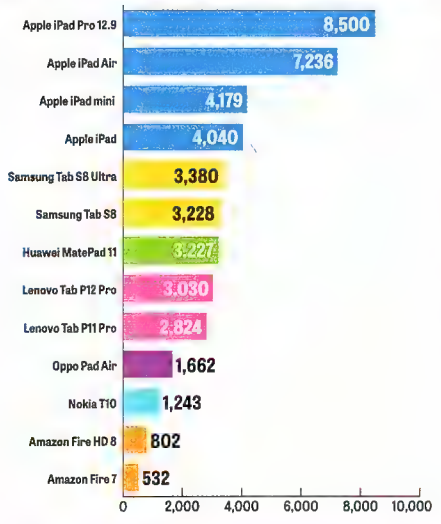
The Tab S8 isn't cheap, and it faces stiff competition from Lenovo and Apple. However, the S Pen and extra storage have to count for something. It's not quite a winner, but it doesn't fall far off the mark.

TEST RESULTS

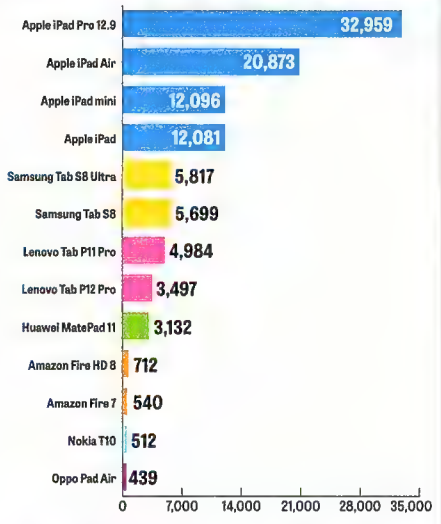
Geekbench 5 single-core



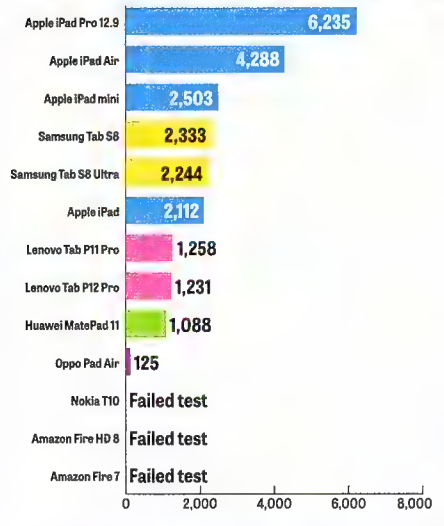
Geekbench 5 multicore



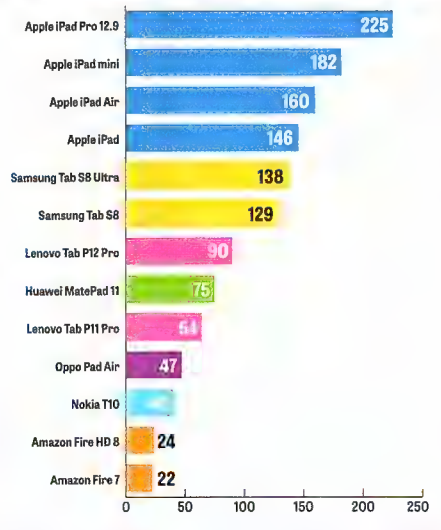
Geekbench 5 Compute (OpenCL/Metal)



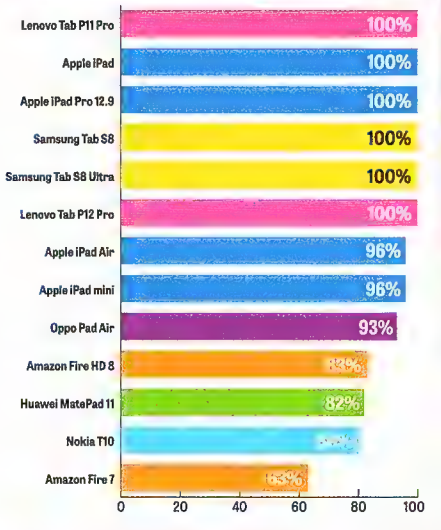
3DMark Wild Life



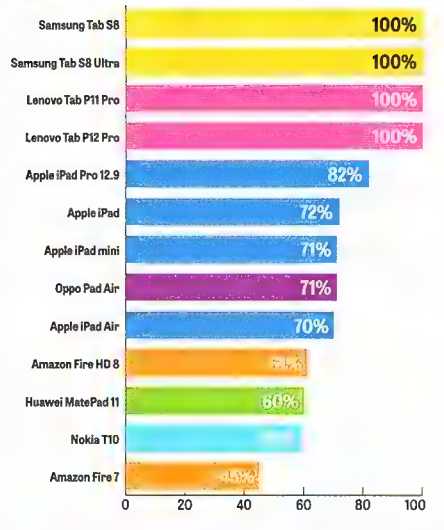
WebXPRT 4



sRGB coverage

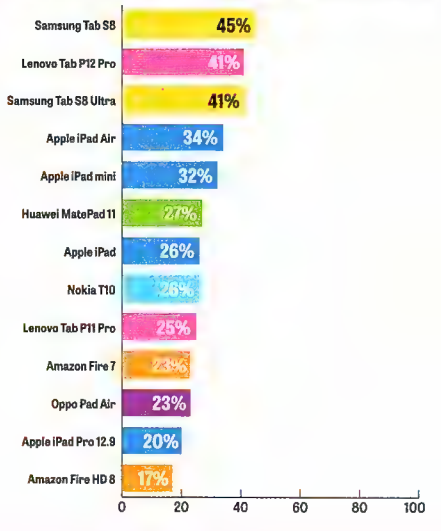


DCI-P3 coverage



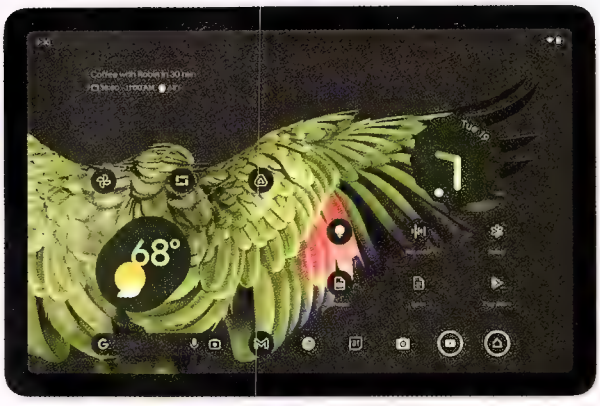
Battery life (video-rundown test)

Battery charge in 30 minutes



WHAT WE KNOW ABOUT THE PIXEL TABLET

A mix of leaks and official statements – plus images and a short video – mean that we have a decent idea of what to expect of this 2023 release.



Google's Pixel Tablet could be a real game-changer, but it's not worth waiting for.

We thought Google had given up on making its own tablets, with the Pixel Slate a long-distant memory, so how pleasant it was to hear news of the Pixel Tablet at the Google IO developer conference in May 2022. At that point it was nothing more than vapourware, but since then a mix of leaks, official imagery and a short video have revealed some valuable clues.

Here's what we know. First, it will use the same Tensor G2 chipset that graces Pixel 7 phones. That's fine by us, as it's a highly capable chip that should run Android 12L smoothly.

We also know how Google intends the tablet to be used. Rather than be "hidden away in a drawer" it wants the Pixel Tablet to be "the heart of your home". To this end, it will be bundling (probably) the Pixel Tablet with a Charging Speaker Dock. This is hardly a new idea, with previous Lenovo tablets coming with just such a dock, but Google promises that it will keep the slate permanently charged and means "you can enjoy hands-free help from the Assistant or a photo frame of your memories". Magnets will keep it safely in place.

Google also promises "enhanced audio from the speaker" that "lets you enjoy your favourite show or have an impromptu dance party". No comment. The final thing we know for sure is that the finish will be "premium nanoceramic", and judging by the released images it will be available in a choice of white or grey.

From hereon in, we come to educated speculation. The video (and leaks) suggest that the Pixel Slate is an 11in tablet, and we know that it has a rear camera – most likely the same 50MP sensor found in the Pixel 7 range.

Rumours suggest it will be affordable, with 4GB of RAM, a choice of 128GB or 256GB storage, and Wi-Fi alone rather than cellular options. That ties in with Google's vision of the device being used at home, and indeed to control your smart home devices, rather than being a portable workhorse.

We don't yet know the Google Tablet's price, and all we can say about availability at this point is that it will be during 2023. All of which means that we don't think it's worth waiting around for: if you see something you like in this Labs, buy it.

The iPad is still out in front of the tablet pack.

View from the Labs

The iPad continues to be a dominant force in tablets despite the best efforts of Samsung et al, but 2023 might just herald a turning point.

Apple's continued dominance of the tablet market isn't just a question of high brand values and marketing mumbo jumbo. And it's not that other manufacturers don't make excellent tablets: as you can see from our reviews and our test results, Samsung, Lenovo and Huawei are all putting superb screens into well-designed bodies with innovative features and impressive specs. When it comes to browsing the web or media consumption, you won't lose anything by ditching Apple for the competition. In fact, with Apple's gruesome price rises, you could save quite a lot of cash.

However, there are two areas where Apple still pulls dramatically ahead. First, the performance of its A15, M1 and M2 processors is proving hard to beat. Even Samsung's latest tablets with Qualcomm's flagship mobile chipsets are struggling to maintain pace, both when it comes to mainstream app performance and 3D games. Second, the iPad still has a huge advantage in terms of software support. Sure, you can do a lot in the browser these days, while there are Android apps for most needs, but if you want to use the biggest apps from the biggest names, or have access to the best range of games to play, then Android plays a distant second fiddle to Apple's line – and there are still too many smartphone apps that have barely been reworked to fill a tablet screen.

The Google camp can fix this, but it's going to take some work. My big hope is that things will start to come together in 2023 with Google building on the foundation of Android 12L, which brought more tablet features into the OS, and with the launch of the new Pixel Tablet, featuring the Tensor G2 chip. The latter could become a real powerhouse, but its wider legacy might be a new wave of app and game development that makes Android a stronger tablet platform. The iPad deserves its leadership position, but it badly needs some competition, too. ■

System News

AMD vaping X3D chips, Nvidia performing sleight of hand tricks and Intel being Graceful, Mark Williams covers some of the events from this year's CES.

Mark Williams
Mark is an IT professional with a strong interest in voiding warranties.

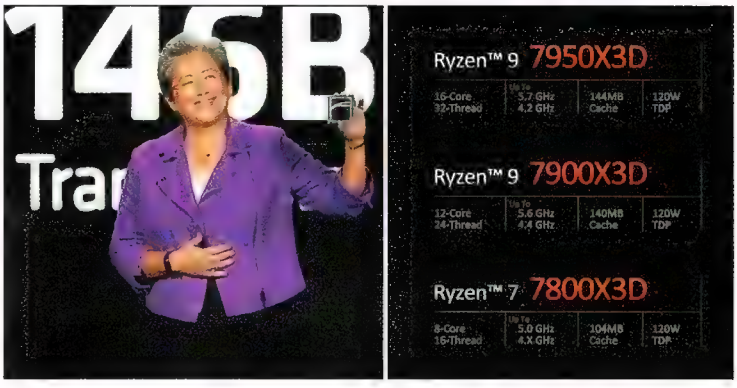
Ryzen 7000 X3D announced

CES kicked off the new year with a bang with many chip announcements from AMD, Intel and Nvidia.

Probably the most anticipated announcement was the Ryzen 7000X3D parts. Following on from the huge success of the 5800X3D, these next generation X3D parts take the same formula of stacking a 3D V-cache chip on top of the latest CPUs to increase L3 cache sizes.

AMD is expanding the range of products this generation to three with the Ryzen 7 7800X3D, Ryzen 9 7900X3D and Ryzen 9 7950X3D. These are all like their non-X3D brethren except when it comes to frequencies. Relative to the Ryzen 7700X the 7800X3D drops 400MHz off its peak boost speed which is larger than the 200MHz loss the 5800X3D saw but still sits 500MHz above said part.

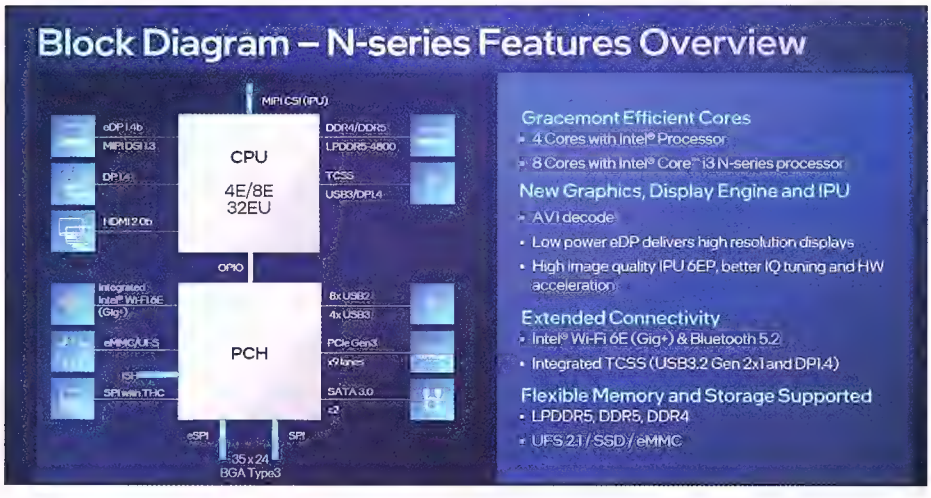
The 7900X3D and 7950X3D are a little more interesting though. Many were expecting these dual CCD parts to have V-cache stacked on both CCDs, however AMD have since confirmed that only one CCD will have the V-cache installed and explains why both processors are able to keep their normal boost clocks of 5.6GHz and 5.7GHz respectively as having this asymmetric cache design means the non-V-cache CCD can boost like normal while the V-cache enabled CCD can benefit applications (notably games) even with a large frequency deficit. Effectively the Ryzen 9 X3D parts get the best of both worlds.



AMD has said it has worked hard with Microsoft to implement scheduler updates in Windows so that the OS can easily delegate threads to the correct CCD for best performance without user intervention. It needs to be seen how that shakes out, but for now AMD is expected to firmly take the performance crown with these when they launch later this year.

Intel i3 N series

Intel announced its new i3 N series of CPUs at CES. With the Pentium and Celeron brands having been discontinued and despite many other CPUs also announced, mostly for mobile, this N series are one of the most interesting lines Intel is currently developing. Based entirely on Intel's efficiency cores, the i3 N300 and N305 both have eight cores clocking up to 3.8GHz sans hyperthreading and TDPs starting at just 7W. These processors utilise the Gracemont architecture found in Alder Lake and Raptor Lake based CPUs and as a result show very impressive gains over former Tremont based CPUs like the former top end quad-core Pentium Silver N6000. With claimed CPU performance gains of up to 70 percent and iGPU gains up to 120 percent.



7900 XTX vapour

AMD had a tough time with its RX 7900 series launch. Not only did the RX 7900 XTX fall short of AMD's performance targets which seemed to be projecting near parity with the RTX 4090 (NB: it ended up only slightly better than the RTX 4080) it also consumes more power than its previous generation halo products when idle or during video playback.

A recent driver update has gone a long way to addressing the power consumption issues with the RX 7900 series and AMD engineers are making it known that they expect to claw back the missing extra performance through driver updates over time. The loss in performance is allegedly down to a bug in the Navi 31 silicon design that AMD says it has already fixed for upcoming Navi 32 and 33 products.

The final kick in the gut came when some users noticed their cards were running extremely hot, specifically, under load the GPU hot-spot temperature would hit 110°C, causing throttling and thus a loss in performance of over 20

SHOP TALK

How many of your customers have been affected by the 7900 XTX cooler issue and seeking replacements/ refunds?

Richard, Aftershock PC:
"To date we haven't had any customers affected by the 7900 XTX cooler issue. We always thoroughly stress test and check the temps prior to sending out the units and we have picked up one unit so far with the hot spot issue during our testing process (prior to delivery to the customer) which was returned to the manufacturer."

percent in some cases.

The community jumped into action, looking for explanations. Youtuber Der8aur went to the extreme of CNC milling out parts of the vapour chamber cooler to figure out what was happening, in the process discovering that there appeared to be very little liquid in the chamber, thus causing a lack of heat transfer due to a phenomenon in heat-pipe and vapour chambers called dry out where the cycle of the liquid inside fails.

AMD soon after in an interview admitted the fault after their own internal investigations and stated that it appears to have been caused by a small bad batch of vapour chambers installed exclusively on RX 7900 XTX cards with AMD reference design coolers on them. AIB models with their own cooler designs and all XT models are unaffected.

AMD said it will replace any faulty card however it stopped short of doing a recall effectively leaving it up to users to notice the issue and report it to AMD's tech support or reseller.

If you have an RX 7900 XTX with a reference cooler on it, you might want to use a utility like GPU-Z while gaming to see if your GPU gets to 110°C (which should never be the case normally) and if it does contact AMD or the reseller where you bought it from to get a replacement.

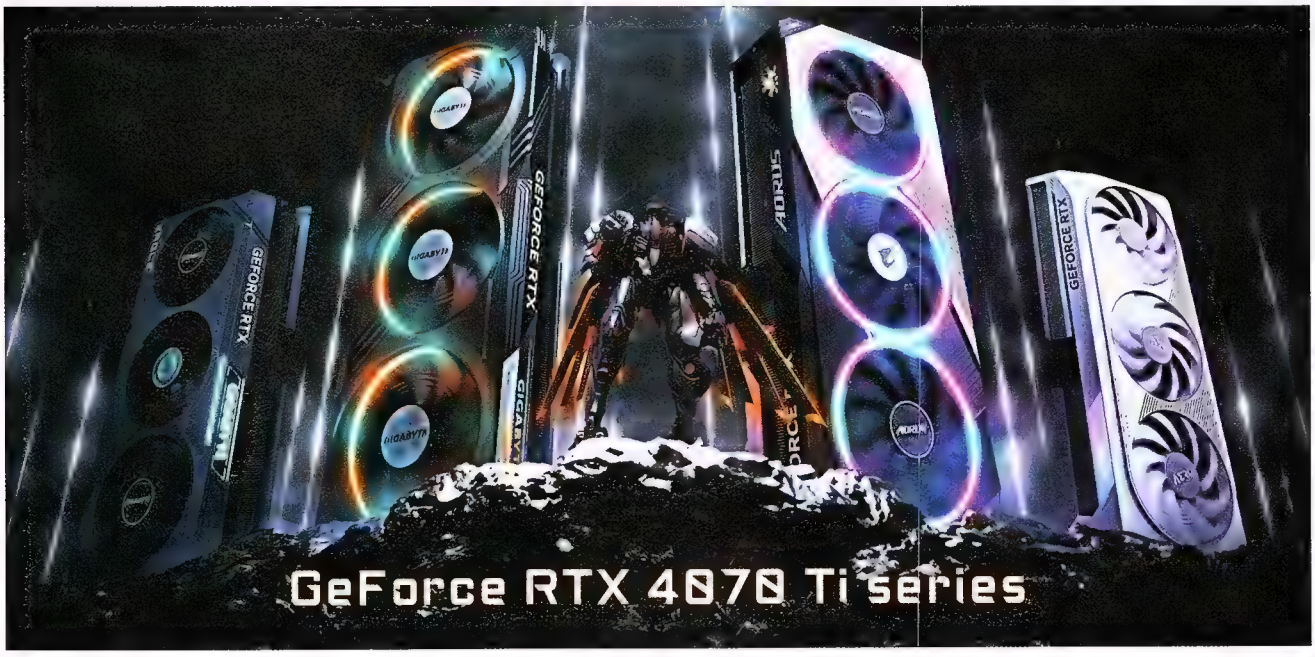
RTX 4070 Ti launches to more disappointment

When Nvidia "unlaunched" the laughably overpriced RTX 4080 12GB card, many suspected the GPU would return as an RTX 4070/Ti model. Low and beyond that's exactly what happened in Nvidia's CES keynote, coming back as the RTX 4070 Ti. The specs remain the same, including the 12GB of VRAM but the price was lowered an extra US$100 below what the RTX 4080 12GB was to be.

Now the product itself is great, offering RTX 3090 Ti levels of raster performance at much lower power consumption and even better raytracing, but when the RTX 3090 Ti with its 24GB of VRAM can be had for the same price, it means the price/performance bar has not budged and ends up making the 4070 Ti very unappealing. Several reports from America and Europe say that it's selling worse than the RTX 4080 which itself was already selling poorly beforehand due to its bad value proposition.

Nvidia seems intent on pushing every tier of card one rung up the pricing ladder compared to last generation, and customers are getting sick of it and voting with their wallets.

Here in Australia, Richard from Aftershock PC noted that "at the moment, our 4080 sales are outperforming the 4070 Ti sales which is a bit of a surprise". ■



© Aorus

PC BUILDER

Market Watch

A sampling of PC systems available this month.

TI COMPUTERS TI STRIX DREAM PC I9 13900KF

$3,520 | tinyurl.com/APC517TI

Weighing in as this month's priciest system, good things should be expected here. Out of the gate, it starts strongly with one of Intel's fastest CPUs. These run hot under heavy loads and it's good to see that it's matched with a beefy 360mm water cooling solution. Being seated in a Z690 motherboard is great too, and will allow for easy tinkering to eke out even more performance should you desire. 1TB of SSD space is adequate as is 32GB of RAM.

Where this build hits a road bump is the graphics card, not only is the RTX 3060 from last generation, it's essentially entry level. Meaning this system is only good value if your typical use case is very CPU demanding.

CPU: Intel i9 13900KF; **Cooler:** Asus ROG Strix LC II 360; **Motherboard:** Asus TUF Gaming Z690-Plus WIFI D4; **Graphics:** 12G DDR6 GeForce RTX 3060; **Memory:** 32G DDR4 Kingston HyperX; **Storage:** 1TB NVMe M.2 SSD; **Power Supply:** 850W; **Case:** Antec NX800 or MSI Velox Airflow Case.

PLE AURORA RTX 4080 READY TO GO GAMING PC

$3,399 | tinyurl.com/APC517PLE

This system takes the opposite approach to the TI Strix Dream PC and goes heavy on the GPU horsepower. So much so that in gaming at 4K this system will easily have triple the performance. With GPUs still being so expensive though this system has had some chunky corners lopped off elsewhere to accommodate the asking price. The CPU whilst solid is not a good match for 1080p or even some 1440p gaming with this calibre of GPU, hampering performance, so make sure you play at resolutions at or higher than 1440p with all the details cranked up high to not bottleneck performance. The 3000MHz RAM is very low-end these days and further holds CPU performance back. Lastly, the 500GB SSD will feel small quickly with just a few big game titles and apps installed. This system is an absolute gaming powerhouse if you're sensible with how you use it.

CPU: AMD Ryzen 5 5600 ; **Cooler:** OEM ; **Motherboard:** Asrock B550M-HDV; **Graphics:** Zotac Gaming GeForce RTX 4080 Trinity OC 16GB; **Memory:** 16GB GeIL Orion DDR4 C16 3000MHz; **Storage:** Kingston NV2 500GB PCIe 4.0 NVMe M.2 SSD; **Power Supply:** SilverStone ET-750HG V1.2 750W; **Case:** Lian Li Lancool II.

BPC TECH SIREN VORTEX ESSENTIAL

$2,999 | tinyurl.com/APC517BPC

What would happen if we took Aftershock's Ultracore Mini – Pro but made it cheaper and faster? Somehow BPC Tech have done just that. Housed in a case that is the closest knockoff we've ever seen of the Lian Li O11D Mini it already looks the part. The CPU of choice here is from last generation, it may have the same number of threads but is composed of more P-cores, meaning more performance on tap.

The RTX 4080 GPU is the big-ticket item here and is over 80 percent faster than the RTX 3070, ouch. The mild downsides to this build are that: the CPU cooler is only a stock Intel unit so expect the CPU to run warm; the motherboard is only a B660 class; and there's only 16GB of RAM. Each of which for the most part isn't too bad considering the cost savings. If purely gaming, this system offers fantastic value.

CPU: Intel i7 12700F; **Cooler:** OEM; **Motherboard:** Gigabyte B660M Aorus Pro; **Graphics:** PNY GeForce RTX 4080 16GB TF Verto Edition; **Memory:** Kingston Fury Beast 16GB 3200MHz CL16 DDR4; **Storage:** PNY CS1031 1TB M.2 NVMe SSD; **Power Supply:** EVGA 850 GQ 850W; **Case:** DarkFlash C305.

AFTERSHOCK PC ULTRACORE MINI - PRO

$3,249 | tinyurl.com/APC517AFT

Cramming lots of horsepower into a small form-factor is never easy, but Aftershock PC has done a good job here. Sporting Intel's best value CPU in the i5-13600K, be it gaming or productivity this system will serve you well. Matched with an RTX 3070 for it gaming chops it's decidedly last generation especially now that the RTX 4070 Ti is available, but this will still handle any games at 1440p with ease. 32GB of RAM is always nice, as too is the 1TB SSD plus 2TB HDD mass storage combo for ample storage space. Housed in a nice case to show off all the RGB, this will make any gamer happy.

CPU: Intel Core i5-13600KF; **Cooler:** Aftershock Spectra Glacier Mirror 280mm; **Motherboard:** Gigabyte Z790 Aorus Elite AX; **Graphics:** MSI RTX 3070 Ventus 3X OC – 8GB; **Memory:** 32GB Kingston Fury Beast Black 5600MHz CL36 DDR5; **Storage:** 1TB Kingston NV2 M.2 NVME, 2TB Seagate Barracuda; **Power Supply:** 750W Corsair SFX; **Case:** Lian Li O11D Mini.

Blueprints

Value- and performance-driven hypothetical builds

BUDGET

A perfect balance between price and peformance.

As peripherals and components come out with new variants and generations all the time, prices naturally creep up – something that has certainly sneaked up on us all within the tech industry. After a recent review of this section, we noticed the prices of our Budget builds had increased, so we've reeled things back, re-evaluated these machines and got them into a more realistic 'budget' level. That may mean the builds taking a hit in performance, but hopefully nothing too drastic.

The first change is to swap out our Intel Core i5-12600K for a more affordable 12th-gen chip that still has integrated graphics, so we've gone for the Intel Core i3-12100. This chip has a max turbo frequency of 4.30GHz, four performance cores, and eight threads. It's a step down from the 12600K, yet this i3-12100 CPU is dependable for a budget machine.

We've also swapped out our Z690 board for an Asrock B660M HDV DDR4 motherboard, which helps reduce costs by around $100. As our processor is no longer a 'K' variant, we can't overclock it so the Z690 would have been wasted. The final change is our RTX 3060 back to an RTX 3050 – for a budget build, this is good enough for a 1080p gaming experience. We've chosen Gigabyte GeForce RTX 3050 Eagle OC 8GB, saving a further $110.

There were fewer changes on the AMD budget machine. The first thing we did was to halve our 4TB drive and go for the 2TB Seagate Barracuda Compute 7200 HDD, which we also added to the Intel machine. A 500GB PNY CS2140 PCIe 4.0 SSD was also brought in for both machines, bringing the total cost for storage to $90 each on the AMD and Intel builds. The main change was to downgrade slightly from an RX 6650XT to an RX 6600XT as the previous GPU we had in from Gigabyte was no longer on sale.

The end result of our culling is a saving of $234 for the AMD build compared to last month, and another $545 in the bank for our modified Intel build. Not bad, not bad at all.

AMD INGREDIENTS

Part		Price
Case	Corsair 4000D Airflow	$140
PSU	550W Cooler Master MWE Gold 80+ Gold	$120
Mobo	Asrock X570 Steel Legend ATX AM4	$245
CPU	AMD Ryzen 5 5600X	$259
GPU	ASRock Radeon RX 6600 XT Challenger D OC 8GB NEW	$369
RAM	16GB (2x 8GB) PNY XLR8 Gaming EPIC-X RGB @ 3200MHz	$99
SSD	500GB PNY CS2140 PCIe 4.0 M.2 SSD NEW	$69
HDD	2TB Seagate Barracuda Compute 7200 NEW	$85
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$1,446

INTEL INGREDIENTS

Part		Price
Case	Corsair 4000D Airflow	$140
PSU	550W Asus ROG Strix 80+ Gold	$140
Mobo	Asrock B660M HDV DDR4 Motherboard NEW	$159
CPU	Intel Core i3-12100 NEW	$209
GPU	Gigabyte GeForce RTX 3050 Eagle OC 8GB NEW	$489
RAM	16GB (2 x 8GB) PNY XLR8 Gaming EPIC-X RGB DDR4 @ 3200MHz NEW	$99
SSD	500GB PNY CS2140 PCIe 4.0 M.2 SSD NEW	$69
HDD	2TB Seagate Barracuda Compute 7200 NEW	$85
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$1,450

"We made a few changes across both Mid-range systems this month – again, with a slight hit to performance to get the systems back to a more appropriate price."

MID-RANGE

A game-ready machine that can also handle demanding work.

As we've shaved a few dollars off our Budget builds, it only seems right to apply the same strategy to our Mid-range builds. We made a few changes across both Mid-range systems this month – again, with a slight hit to performance to get the systems back to a more appropriate price. GPU prices haven't helped, and as we're choosing to keep up to date by using the latest 13th gen Intel chips and AMD Ryzen 7000 series processors, the rest of the accompanying components aren't currently the cheapest.

Kicking things off with AMD, we've downgraded from an RX 6800XT to an RX 6750XT saving us $150 . The RX 6750XT is still a decent GPU for 1080p and even 1440p gaming, and is perfect for our mid-range build.

Three other changes also made it over to the Intel PC – the PSU, RAM, and HDD. For the latter, we used the 2TB Seagate Barracuda Compute 7200 HDD from the budget machines. That's plenty of storage and, at $85, it's hard to turn down.

When making all the relative changes to the builds, both had estimated wattages of under 550W but, to be sure, we gave both Corsair's RM650 PSU in case of any overclocking and also as a safety net. For the RAM, we chose the same Corsair Vengeance DDR5 sticks as before but opted for the slower speeds of 4800MHz instead of 5200MHz to save a few bucks.

The team Intel machine also saw a change in GPU to the Asus GeForce RTX 3070 Dual V2 OC 8GB from the previous Gigabyte RTX 3070 Ti. Again, this was done to save money while also maintaining reasonable performance. Other changes include changing the SSD to 1TB of Corsair's MP600 PRO NH M.2 and also swapping out the motherboard from the MSI PRO Z690-A ATX to Asrock's Z690 Phantom Gaming 4/D5 ATX. That's an overall saving of $298 on the Intel machine and $502 on the AMD build.

AMD INGREDIENTS

Part		Price
Case	Nzxt H7 Flow	$219
PSU	650W Corsair RM650 80+ Gold NEW	$175
Mobo	Asrock B650E PG Riptide WIFI ATX AM5	$399
CPU	AMD Ryzen 7 7700X	$529
Cooler	Cooler Master MasterLiquid ML240L RGB V2	$95
GPU	MSI Radeon RX 6750 XT Mech 2X OC 12GB NEW	$799
RAM	32GB (2 x 16GB) Corsair Vengeance DDR5 CL40 @ 4800MHz NEW	$229
SSD	1TB Crucial P5 Plus NVME M.2 PCIe 4.0	$165
HDD	2TB Seagate Barracuda Compute 7200 NEW	$85
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$2,755

INTEL INGREDIENTS

Part		Price
Case	Nzxt H7 Flow	$219
PSU	650W Corsair RM650 80+ Gold NEW	$175
Mobo	Asrock Z690 Phantom Gaming 4/D5 ATX LGA 1700 NEW	$259
CPU	Intel Core i5-13600K	$499
Cooler	Cooler Master MasterLiquid ML240L RGB V2	$95
GPU	Asus GeForce RTX 3070 Dual V2 OC 8GB NEW	$879
RAM	32GB (2 x 16GB) Corsair Vengeance DDR5 CL40 @ 4800MHz NEW	$229
SSD	1TB Corsair MP600 PRO NH M.2 PCIe 4.0 NEW	$229
HDD	2TB Seagate Barracuda Compute 7200 NEW	$85
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$2,729

"Turbo machines are designed to showcase the latest and greatest peripherals, but we'll obviously still try and shave a few dollars off where we can. "

TURBO

The maximum PC.

Finally, we have the Turbo builds – our top-tier machines with an emphasis on power and style. We considered cutting the costs here too, however, our Turbo machines are designed to showcase the latest and greatest peripherals, but we'll obviously still try and shave a few dollars off where we can.

Starting with the AMD Turbo build, it's about time to add a new next-gen GPU into the mix. We opted for the Radeon RX 7900XT card instead of the top-end Radeon RX 7900XTX. It's slightly down on power compared with its sibling and compared with the GPU on the Intel side, but this 7900XT comes with 20GB of GDDR6, DisplayPort 2.1 connectivity, a boost clock of 2560 MHz, and AMD's RDNA 3 Architecture for reliable 4K gaming.

We specifically chose the XFX Speedster MERC 310 Black Edition card as we could pick it up for under $1,700. On the other hand, the RX 7900XTX was way over its RRP, which is a heavy premium for that card. GPU aside, the build remains the same, as we'd already brought in the AMD Ryzen 9 7900X AM5 chip and accompanying components previously.

There's no change in GPU with the Intel Turbo build, the Asus TUF Gaming OC GeForce RTX 4090 24 GB may be eye-wateringly expensive, but it remnains one of the best 'value' RTX 4090s out there at the moment.

GPU aside, we brought in the Asrock Z790 PG Lightning DDR5 ATX motherboard to replace the Gigabyte Z790 Aorus Elite AX DDR5 ATX, saving around $180 in total. Other than that, nothing else changed on either of the Turbo builds, and we're very pleased with where they stand right now.

In terms of savings compared to last month, we're up an even $500 for the AMD PC, and a healthy $839 for Intel, which remains hampered by the incomprehensibly expensive Nvidia RTX 4090.

AMD INGREDIENTS

Part		Price
Case	Phanteks Enthoo Pro 2 Tempered Glass	$220
PSU	1000W Corsair RM1000 80+ Gold NEW	$299
Mobo	Asrock X670E PG Lightning ATX AM5	$449
CPU	AMD Ryzen 9 7900X	$739
Cooler	Cooler Master MasterLiquid ML360R RGB 66.7 CFM 360mm	$149
GPU	XFX Speedster MERC 310 Black Edition Radeon RX 7900 XT 20GB NEW	$1,699
RAM	64GB (2x 32GB) Corsair Vengeance DDR5 CL40 @ 5200MHz	$449
SSD	1TB WD Black SN850X M.2 PCIe 4.0	$249
HDD	6TB WD Blue 5400 HDD	$189
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$4,502

INTEL INGREDIENTS

Part		Price
Case	Phanteks Enthoo Pro 2 Tempered Glass	$220
PSU	1000W Corsair RM1000 80+ Gold	$299
Mobo	Asrock Z790 PG Lightning DDR5 LGA 1700 NEW	$360
CPU	Intel Core i9-13900K	$999
Cooler	Nzxt Kraken X73 73.11 CFM 360mm	$279
GPU	Asus GeForce RTX 4090 TUF Gaming OC 24GB NEW	$3,459
RAM	64GB (2x 32GB) Corsair Vengeance DDR5 CL40 @ 5200MHz	$449
SSD	1TB WD Black SN850X M.2 PCIe 4.0	$249
HDD	6TB WD Blue 5400 HDD	$189
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$6,563

QUICK TIPS

The problem solvers

The APC team field problems across the spectrum of devices and software. Learn a new trick or fix you can use.

Megahertz madness

I was recently exploring my router's settings – more through curiosity than any particular need. While there, I found an option to adjust channel widths. It was preset to 20/40/80MHz, but there was a tick box to enable 160MHz. What does this mean and what's the difference between them? Bigger usually means better, so should I enable the 160MHz option?
James McCarthy

APC responds: It can, but this is a complex area where sometimes less is more. By necessity, we're going to have to simplify matters. Though not a perfect analogy, think of Wi-Fi bands such as 2.4GHz and 5GHz as highways. In this context, the channels are lanes. Each lane can carry only so much data – or vehicles, to stretch our analogy. A standard channel on either band has a lane 'width' of 20MHz, enough for narrow vehicles only.

Here, our analogy breaks down a little, but to send more data, more efficiently, wider vehicles are needed and that means wider lanes (channels). Modern Wi-Fi kit allows the use of 'bonded' channels, so two 20MHz channels can become one with a 40MHz width, while four provide an 80MHz lane.

Modern routers, such as the TP-Link Archer AX55, support bonding of up to eight channels, for a 160MHz lane width. In theory, that would allow the router to transfer data to compatible devices much faster than is possible with 'narrower' channels.

That sounds good, but there is interference to consider. Just as a wide vehicle can interfere with other road traffic, so too does an expansive Wi-Fi channel restrict space available for data that's unable to travel that route. Not all devices are compatible with 160MHz lanes, so enabling this option may result in better performance for some devices but worse for others.

For most people, this stuff is best left to the router and devices. However, don't be afraid to enable the option. You can always switch it off if any of your connections are adversely affected.

OneDrive half full or half empty?

Microsoft's constant prodding to get me to back up my data to OneDrive has obviously worked, as I now make sure all of my data is saved on its cloud. However, I recently received an email telling me that my OneDrive was almost full. I've been creating some large files for our local magazine lately, so how do I check how much space I am 'allowed', and how much I've used on OneDrive?
John Howell

> "I recently received an email telling me that my OneDrive was almost full. I've been creating some large files for our local magazine lately, so how do I check how much space I am 'allowed', and how much I've used on OneDrive?"

APC responds: This is one of those obvious-when-you-know-how kind of problems, so APC is happy to help.

Unless you're paying Microsoft for extra storage (via a Microsoft 365 subscription), then the standard OneDrive allocation is 5GB. To check what you have, right-click the OneDrive icon in the notification area on the right side of the Windows taskbar, then click the cog icon, followed by Settings. Now click to select the Account tab and you'll see your current tally and allocation.

For more detail, or to upgrade your storage quota, click the 'Manage storage' link. You'll be directed to the web version of OneDrive, where you can see what's what. To see options for more storage, click the 'Plans and upgrades' link on the left.

Microsoft can be annoying with its constant reminders to use OneDrive, but its storage plans are pretty competitive, especially if you have family or friends with whom you can share the Microsoft 365 Family plan. And if you're a heavy Windows user, the seamless syncing of files across devices is pretty neat, too.

Windows 11 Plan B

I've been reading in your fine publication that Windows 11 take-up has been rather slow and, I'm afraid to say, I'm one of the people contributing to this. I'm ready to take the plunge now that it's more stable and compatible, but I want to make sure that if I upgrade from Windows 10 to 11, can I go back to 10 if I don't like it? Also, if I can make the choice to go back, will I still be able to upgrade to Windows 11 later on, or Windows 12 if that's what Microsoft releases next?
Bernie Weatherford

APC responds: We can understand the trepidation about upgrading, especially for professionals where stability is key. Bear in mind that while you can downgrade to Windows 10, Microsoft makes that option available for 10 days only. Beyond that time frame, the only way to go back to Windows 10 is by wiping Windows 11 and performing a 'clean' install.

Within the 10-day period, click the Start button followed by the Settings cog, and then System followed by Recovery. Under 'Recovery options' click 'Go back' and then follow the prompts.

No one can say with any certainty if or when Microsoft will turn off the free upgrade option, or whether that offer will be available from Windows 10 to 12, if it arrives. However, based on past behavior, we're confident you'll be able to upgrade from Windows 10 for a long while yet.

We're also fairly sure that, in a Windows 12 future, Microsoft would allow people to jump straight from 10 to 12 – just as Windows 8/8.1 users can jump to Windows 10 (and then to 11, hardware compatibility permitting).

Getting out of a time loop

I have a nine-year-old Alienware M14 laptop that I cannot bring myself to replace. Every time it's switched on, I have to manually set the date and time via the time.windows.com server.

There are no beeps to signify a fault and the laptop otherwise works fine. I suspect a failed CMOS battery, but this laptop requires significant disassembly to get at it.

However, given the lack of beeps or errors, I wonder if there could be something else that's causing this whole issue.
Em Archer

Settings
Find a setting
System
Bluetooth & devices
Network & internet
Personalization
Apps
Accounts
Time & language
Gaming
Accessibility
System › Recovery
If you're having problems with your PC or want to reset it, these recovery options might help.
Fix problems without resetting your PC
Resetting can take a while — first, try resolving issues by running a troubleshooter
Recovery options
Reset this PC
Choose to keep or remove your personal files, then reinstall Windows
Reset PC
Go back
If this version isn't working, try going back to Windows 10
Go back
You can always roll back to Windows 10 from Win11, once installed. But be quick, as you've only got ten days to do it.
Advanced startup
Restart your device to change startup
Restart now

APC responds: You're right that this problem is symptomatic of a CMOS battery that's run out of power – and after the best part of a decade, that's likely to be the case. So why aren't you getting broader, BIOS-related error messages?

Well, that's because while some laptops use a CMOS battery to ensure BIOS settings are saved, just like a desktop PC, more advanced models store these essentials in a special area of 'non-volatile' flash memory – the sort that doesn't forget its contents when the power is removed. That leaves the CMOS battery responsible only for powering the machine's real-time clock (RTC) function, as no powered-down computer can keep time without it.

So, that's the explanation. The fix, as you know, is to strip down the machine to get to the battery, or just put up with resetting the clock after each power down. It's annoying, but sadly the only options available without calling it a day for the Alienware and upgrading your laptop.

Linux and Windows in harmony

I've been toying around with Linux on a Raspberry Pi, and I've enjoyed it so much I'd like to occasionally run a Linux operating system on my PC. I don't want to do this from a live disk, but I also don't want to use any of my limited NVMe boot drive's space either. What's the simplest solution?
Peter Fairfax

APC responds: Thanks to the great leap forward brought by USB 3.0, you can run Linux (or indeed Windows) from an external SSD. USB 3.0 transfers data at 5Gbps, which means any external SSD will do.

However, if you have USB 3.1 ports, you can double this speed – just make sure you pick a drive capable of delivering up to 10Gbps, such as Samsung's T7.

Taking Ubuntu (**https:// ubuntu.com**) as a good example of Linux to install, the key thing is to choose 'Something else' under Installation type when installing. This is the most vital requirement – make sure you correctly identify your drive by size and used space (it definitely won't be 'dev/sda', which is your Windows drive).

Once identified, select the current NTFS or FAT32 partition and click the '–' (dash) button to remove it, then click '+' (plus) to create an ext4 journaling partition in its place. Now select this newly created partition and let the installer continue.

Once finished, whenever you want to boot to Linux, simply override your default boot drive at startup (typically press F11 to bring up the boot menu) and instead choose your external SSD to boot from. After that, you should be able to get cracking and have some open-source fun!

Dreaming of dual booting

I'm trying to dual-boot Windows 10 and 11 on the same NVMe drive, which has 700GB free from a total of 1TB. I've tried shrinking the Windows 10 system drive to free up 500GB of space using Disk Management in Windows, but it's adamant it can only free up to 100GB. That won't be enough for my needs. Any ideas as to what should I do?
James Pelton

APC responds: The reason Disk Management can't give you access to all the available space on the drive is that it doesn't reboot Windows during the partitioning process. As a result, it's unable to handle unmovable files such as page files, which often sit near the end of the volume, keeping them out of the way of other file operations to prevent disks from fragmenting. Windows judges available free space from where this last file ends.

You may get lucky and find that after a couple of reboots, Windows rearranges the files in such a way as to allow the drive to be shrunk, but a quicker and easier option is to use a third-party partitioning tool, which reboots during the resizing process to bypass the issue of where files are stored on the drive. The reboot allows the files to be removed or rearranged as required to free up to 100 percent of the reported available space.

One such tool is Paragon Partition Manager Community Edition, which is free for personal use. On our test PC (a 230GB drive with 35GB free space), Paragon was able to shrink the partition by the full amount after Windows' Disk Management tool claimed that only 2.4GB could be freed up. ■

© Microsoft

WINDOWS

Streamline and speed up your PC

Nick Peers will help you bring your PC back to life.

YOU'LL NEED
BootRacer and Autoruns
Wise Game Booster (for on-the-fly optimisation)
Process Lasso (to rein in resource hogs)

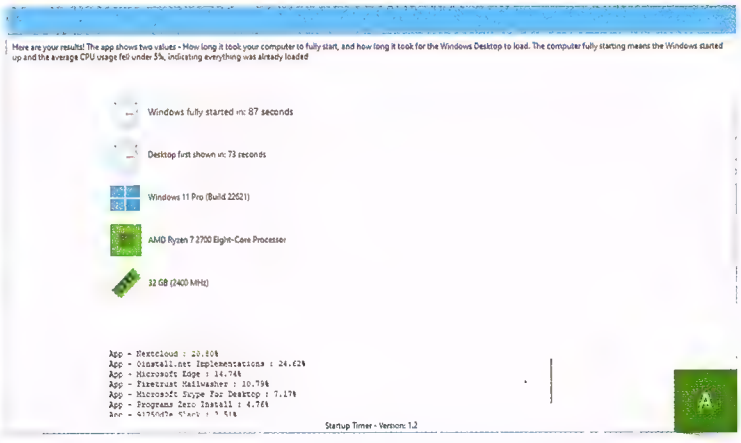
Does your PC take longer to boot than it used to? In most cases, you can trace this to the growing number of apps on your system, thanks to their tendency to insert themselves into the start-up process even when they're not essential. What about other parts of your system? Does your PC suddenly struggle to play certain games, or have you started to notice things grinding to a temporary halt every now and then for no obvious reason?

If the answer to any of these frustrations is yes, it sounds as though Windows needs streamlining to eliminate the resource hogs and divert precious system resources to where they're most needed. In this issue, we'll focus on eliminating those bottlenecks and reveal ways in which you can keep unruly processes from disrupting your computing life.

We'll benchmark your current start-up times and reveal how to cut back on the programs that load with Windows (spoiler – only a few should start with your OS), then reveal the various ways in which you can keep your PC running smoothly, from freeing up system resources when you need an extra bit of oomph to ensuring errant processes are kept in check.

Understand Windows startup

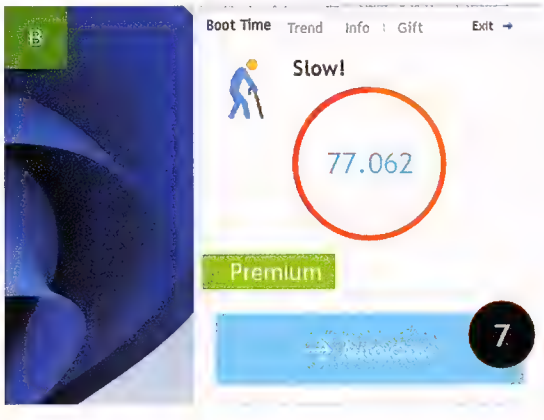
No, you're not imagining things – your PC really does take longer to start than it used to. As you install new apps, a surprisingly large number attach themselves to Windows' start-up routine, which is fine for essential software like your security package, but not so great when all the app is doing is shaving a few seconds from its own start-up time by reserving a section of RAM for itself. And there's the rub: not only do start-up apps extend your boot time but they also eat into your precious system resources, creating a drag on your PC's day-to-day performance.


Here are your results! The app shows two values - How long it took your computer to fully start, and how long it took for the Windows Desktop to load. The computer fully starting means the Windows started up and the average CPU usage fell under 5%, indicating everything was already loaded
Windows fully started in: 87 seconds
Desktop first shown in: 73 seconds
Windows 11 Pro (Build 22621)
AMD Ryzen 7 2700 Eight-Core Processor
32 GB (2400 MHz)
App - Nextcloud : 20.80%
App - Dinstall.net Implementations : 24.62%
App - Microsoft Edge : 14.74%
App - Trancrist Malleashez : 10.79%
App - Microsoft Skype For Desktop : 7.17%
App - Programs Zero Install : 4.76%
A
Startup Timer - Version: 1.2

Sometimes, though, a slow boot time is indicative of something else, particularly if your PC takes an age to reach the login screen. The box reveals the various phases of the start-up routine, and what to do if you experience delays even before reaching the login screen.

In most cases, however, your slow startup can be traced to too many apps loading with Windows. Step one to addressing the problem lies in benchmarking your startup. Using a stopwatch is fiddly, but the good news is that there are apps out there that can do the job for you.

For a quick and dirty benchmark of how long Windows take to load, followed by how long for all those apps to load themselves, try the portable version of Startup Timer (**https://startuptimer.com/**). You'll get two figures: 'a fully started', plus 'desktop first shown in' [Image A]. Beneath this is a list of detected start-up items, each with a percentage figure allocated to them – the bigger this is, the longer that app requires to load.



Benchmark your startup

Startup Timer is useful as a quick exercise, but for a more detailed look – and access to tools to help optimise your startup – head to **https://greatis.com/bootracer/** to download the free version of BootRacer. After extracting BootRacerSetup.exe from boot_racer.zip, double-click the file and install the application. Once done, leave all four boxes ticked and click Finish.

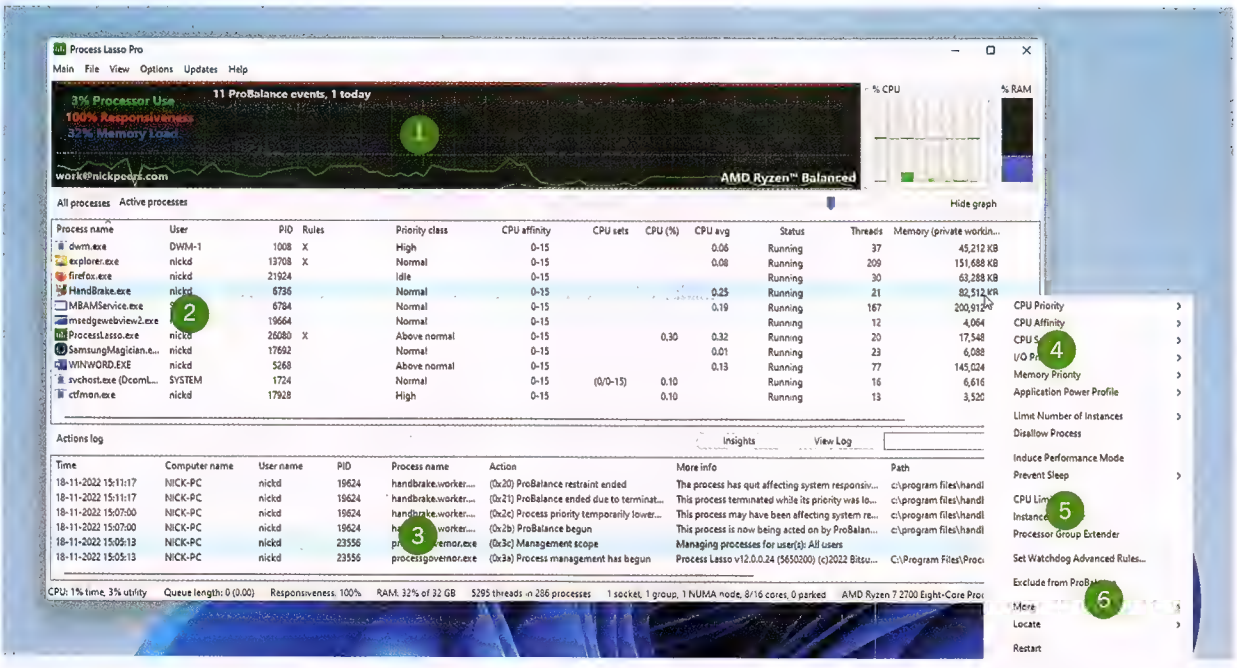
When the main screen appears, you'll see two options, Full Boot Test and Startup Control, plus a large Start button. Click this to open the Quick Speedup tab of Startup Control and click 'Start Test' followed by Yes to reboot and perform a full benchmark of your system.

When you next log in, you'll see a series of messages above the Taskbar notification area revealing BootRacer is monitoring your system. Among these is a countdown clock declaring "Windows is almost ready". As start-up items load around you, the clock will keep resetting to 10. Eventually, it counts down to zero and you'll get your first report [Image B]. It's likely to say average or slow, indicating that there's room for improvement.

Underneath is a blue button that alternates between 'Auto close' and 'Know more?'. Click this to start our deep dive into optimising your startup. If it closes, open BootRacer via the Start menu or search tool.

Examine results

A window opens with a detailed summary of the boot results. BootRacer splits the boot process into



MANAGE YOUR SYSTEM WITH PROCESS LASSO

1. SYSTEM RESOURCE USAGE

This graph tracks your processor's CPU use and responsiveness, plus memory load. When a process threatens to reduce overall responsiveness, Process Lasso steps in.

2. PROCESS INFORMATION

Monitor how individual processes are performing. To focus on running apps, switch to the Active Processes tab to filter system processes.

3. ACTIONS LOG

This enables you to track how Process Lasso monitors – and manages – your processes. Look for references to ProBalance being enforced on resource-heavy apps.

4. MANUAL SETTINGS

In most cases, Process Lasso knows what it's doing, but if you need to override it for any reason, right-clicking the process allows you to do so.

5. CPU LIMITER

This setting allows you to restrict the number of processor cores available to the selected process when the system needs additional resources.

6. BYPASS PRO-BALANCE

There will be times when you want certain apps or services to have access to all the resources they need – select 'Exclude from ProBalance' to prevent Process Lasso from managing them.

four stages: Pre-boot (your PC's initial hardware checks), Windows Boot, Password Timeout (the time while your PC is sitting at the login screen waiting for you to act), and Desktop. Each section is given a time in seconds, but only the Windows Boot and Desktop times count toward the final Boot Result calculation [Image C].

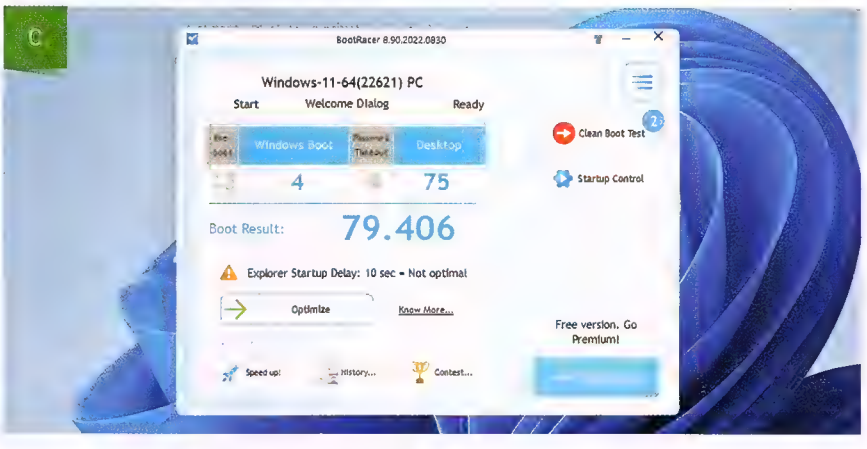
Beneath this is a reference to 'Explorer Startup Delay: 10 sec=Not optimal'. Confusingly, this isn't a reference to the 'Windows is almost ready' clock you saw earlier but is actually a reference to an arbitrary 10-second delay Windows inserts into the post-logon process before start-up apps are processed.

Leaving it in place ensures the desktop is ready to use more quickly, but if you needed to prioritise a specific start-up app or you're running a fast machine where the delay isn't as important then you can reduce the delay to just two seconds by clicking Optimise followed by 'Remove Delay: 10 Seconds'.

BootRacer will tell you this is a premium feature, but by clicking the 'Use Free Bonus' button it will set the delay to just two seconds instead.

You'll be prompted to 'Restart Computer' to apply these changes to see whether BootRacer measures any improvement. If you want to go further and disable the delay entirely, you can open Registry Editor (press Win-R, type regedit and hit Enter) and navigate to the following key:

Computer\HKEY_CURRENT_USER\Software\Microsoft\Windows



CurrentVersion\Explorer\Serialize

Double-click the Startupdelayinmsec value in the right-hand pane and change its value from 2,000 (milliseconds) to 0. Reboot and benchmark the change.

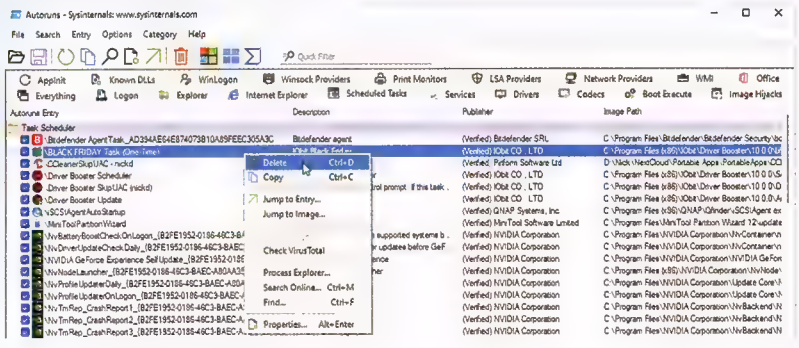
Should you find the tweak adversely affects boot times – that's more common on older PCs and those running from slower hard drives – then simply click Optimise or Change again under Explorer Startup Delay, but this time click 'Restore Factory Settings', which simply deletes the Startupdelayinmsec value in Registry Editor to reinstate the default 10-second delay.

Review app start times

Thankfully, the main bulk of BootRacer's Startup Optimizer tools are free to use. First, you need to enable the feature—look for the 'Enable Control' button in the carousel beneath the boot result (if it's not showing, click the first tab beneath the carousel to bring it back into focus). After clicking this, tick the box under 'Enable Startup Control', then switch to the 'Enable Measuring Startup Time' tab and click 'Restart your PC and Analyse Results' to reboot and benchmark your startup once again.

This time, when you log back in, you'll see BootRacer has instigated its own delay on launching start-up apps – once the timer counts down to zero, it starts loading them in sequence (and measuring their start-up times). Once finished, you should discover this simple tweak on BootRacer's part may have already delivered noticeable savings on top of any recorded by disabling Windows' 10-second delay.

You'll also see exactly how many apps are set to start with Windows – by clicking the 'Check Results' button followed by 'Find Slowdown...' under 'Startup programs times:' you'll be shown a list of apps in the order they loaded along with the time it took for them to start [Image D]. Look out for items marked in red as particularly slow starters, one notable example is Java's update scheduler.



FINER START-UP CONTROL

If you want more control over startup, including viewing hidden parts of the start-up process, download Autoruns from https://docs.microsoft.com/en-us/sysinternals/ You'll find it under Process Utilities. Unzip its contents and then right-click either Autoruns.exe (32-bit) or Autoruns64.exe (64-bit) and choose 'Run as administrator' to launch it.

You'll see a huge list of items appear under an all-encompassing Everything tab. The trick is to quickly navigate away from this tab to focus on specific start-up types. The Logon tab closely approximates what's shown by BootRacer but may well include additional entries. You'll also see that those items you have disabled or removed in BootRacer are shown as being enabled here – that's because BootRacer suppresses this list in favour of its own settings (uninstall BootRacer, and they will all flood back).

Some tabs are empty but focus on Scheduled Tasks as well as Explorer and Services tabs. Look for items marked in red or yellow – try disabling these first by unticking them. If there are no consequences, you can later right-click them to delete them. Another benefit of Autoruns is that it allows you to check start-up entries for possible malware – right-click an entry and choose 'Check VirusTotal' to upload the file in question for a quick online malware scan.

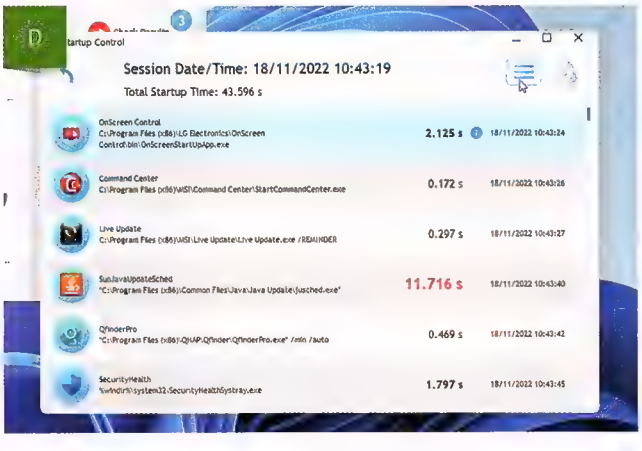
OptimiSe startup

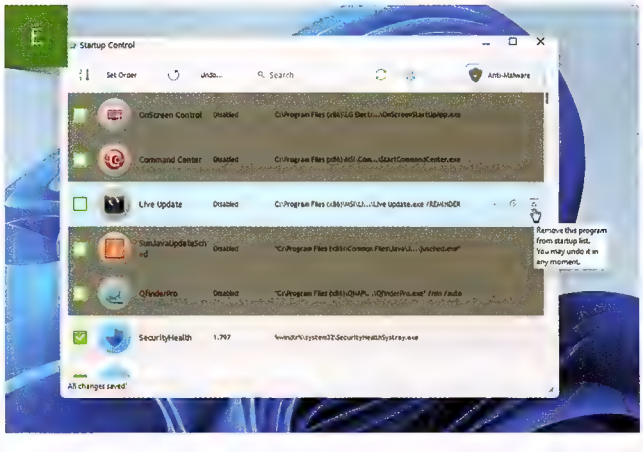
Once you've made a note, close the window and click the Startup Control button to start managing the list. Start by disabling those you don't need starting with Windows – they will either take longer to start, or you'll need to remember to check for updates manually. To do this, simply remove the tick next to the program and you'll see its status set to Disabled.

If you're convinced you don't need a start-up program, you can delete it permanently from the list – roll your mouse over it and click the bin icon [Image E], although we suggest first disabling it and monitoring startup over several days to ensure it's not actually needed for any reason.

As you trim the list, click 'Undo...' if you accidentally remove a start-up item and want it restored. The next thing to do is change the order in which items are loaded during startup. If there's an app you want to be available quickly, click the 'Set Order' button and use the arrows to promote it up the list.

You may notice an 'Anti-Malware' button in the top right-hand corner – this is a Premium feature, so ignore it; your existing security software should already be offering protection against this, but you can also vet your start-up items for free using another start-up





manager (see the box).

Once you've finished tweaking, reboot your PC and your start-up times should improve further. You may also notice, particularly on lower-powered machines, that your PC is faster in day-to-day use too. In future, you can disable BootRacer or leave it to monitor your start-up times to ensure you don't slip into bad habits. Don't panic if, occasionally, boot times are much slower; this can occur when installing Windows updates.

OptimiSe your services

Start-up apps is just one area where you can trim the fat from system resources. Services – low-level programs used by both Windows and third parties such as your security tools– is another area where there may be opportunities to reclaim some precious resources.

There are two ways to tweak services – on an ad-hoc basis whenever you need additional system resources for certain tasks, from playing games to ripping media, or more permanently. The former option is best for most because it allows you to squeeze every last bit of performance out of your system by temporarily disabling both background tasks as well as services that can quickly be restored once you're done with a single click.

This type of app is commonly referred to as a game booster for obvious reasons, but can of course be used whenever you need that extra burst of speed. There are dozens to choose from, and they all do much the same thing. One simple-to-use tool is Smart Game Booster (**https://gamebooster.itopvpn.com**).

The Free version contains all the key functionality you need – just click Boost before playing a game. You'll be shown the performance uplift, typically around 10 percent, and when you're done, click Restore to bring things back to how they were.

Manually tweak your system

One-click apps are all well and good, but if you want to exert more fine control over your system, we recommend trying another lightweight (and free) tool called Wise Game Booster (**www.wisecleaner.com/wise-game-booster.html**).

The program opens to the empty 'My Games' tab, where you can store shortcuts to any application you like. Beneath this will be a list of 'issues' the program has found, divided into three sections. You can choose to optimise them all from here, but it's a good idea to review what kind of optimisations to expect by exploring the System Optimizer, Process Optimiser, and Service Optimiser tabs in turn.

System Optimiser contains no fewer than 35 'recommended' optimizations, some of which may already be set by your system. These optimisations are best reviewed carefully and set as permanent tweaks to your system. Note, if you click 'Resume All' to undo them, all optimisations, not just those you've set in the program, are removed.

Of more potential use for quickly clearing resources for gaming is Process Optimizer [Image F], which identifies memory-intensive processes that Wise Game Booster thinks are worth ending – clicking 'Optimize All' will end these promptly with no 'restore all' button, so review carefully before diving in.

Finally, Service Optimizer identifies what the program describes as 'irrelevant' services that can be safely ended to provide an extra boost – again an 'Optimise All' button exists to speed things up.

Rein in runaway processes

Another way to allocate your PC's finite resources is by managing your processes' priorities. The higher the priority, the more demands a process can make on the system. By default, most processes are set to run at 'Normal', but there are options to give processes more (Above normal, High) or less (Below normal, Low) priority compared to others. You can set these manually via Task Manager's Details tab (right-click a process and choose 'Set priority'), but it's a fiddly process and there's potential to bring your PC grinding to a halt, and not simply by accidentally setting a process to Realtime, thereby giving it a higher priority than Windows.

Thankfully, some tools allow you to better manage the competing demands of processes. Though they are more suited to low-powered PCs that struggle whenever you open more than a couple of browser tabs, these tools can help higher-end PCs too.

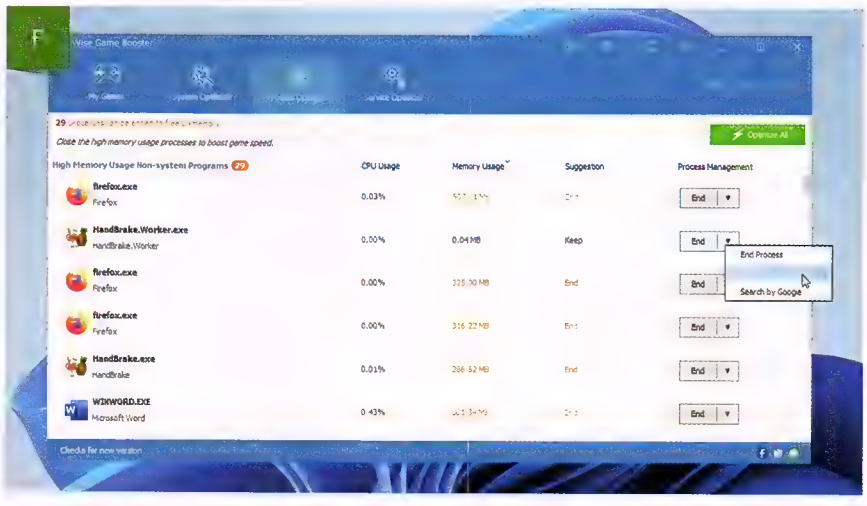
Our favourite tool is Process Lasso (**https://bitsum.com/**). The annotation opposite provides you with a key run down of its features, while a Pro license gives you complete control of your system (prices start from US$25 for a one-year, single-PC license, but US$40 buys you a lifetime license), the free version has all the core functionality you need if you're happy for the app to do the heavy lifting for you. ■

FIX START-UP DELAYS

The boot process consists of several phases: first is Pre-boot when your hardware runs start-up checks and the boot manager waits to hand over to your selected operating system. Next is the Windows loading process (Windows Boot), then a pause at the login screen, followed by the post-logon process (or Desktop), as Windows loads your user profile along with apps configured to run at startup.

If your pre-boot time is longer than five seconds, this may indicate several things: you may not have enabled Fast Boot in your system UEFI – there may be a reason for this (dual-booting with Linux), otherwise, give it a go. There may also be a delay if you have a dual-boot menu that pauses for a lengthy period before booting the default OS.

Delays in the Windows Boot portion of the boot process may indicate errors on the drive (press Win-X, choose 'Terminal (Admin)' or 'Command Prompt (Admin)', then run 'chkdsk c: /f /r /x', selecting yes to perform the check and repair on your next boot). If you've not yet upgraded your boot drive to SATA or NVMe, you might also want to check to make sure it has recently been defragged (type defrag into the Search box).



MAC OS

Master System Settings

The Mac's preferences interface has a new look and a new name.

IT WILL TAKE
5 minutes

YOU WILL LEARN
How to open and navigate System Settings to configure your Mac

YOU'LL NEED
macOS 13

Apple's ongoing plan to bring its operating systems closer together and form a single all-purpose ecosystem took another step forward with macOS Ventura, as System Preferences got an iOS-inspired makeover.

Now called System Settings, it functions in much the same way as the old System Preferences, but instead of being arranged in a grid of preference panes, it's now far more like the Settings app in iOS and iPadOS, with a long list of individual settings options. In macOS, this list is set into a sidebar, with the settings options themselves in the main window.

Unlike Apple's mobile devices, it doesn't offer settings for individual apps that came bundled with the OS or that you've installed yourself. These are still found in the app itself, under the pull-down bearing its name. But all the Mac system configurations are achieved through this new System Settings interface.

Ian Osborne

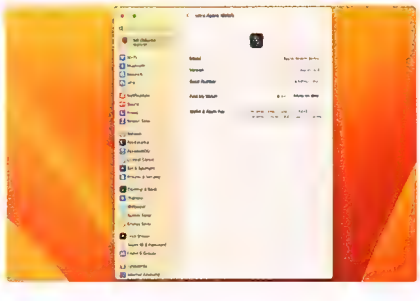
HOW TO CONFIGURE YOUR MAC IN SYSTEM SETTINGS

1 OPENING SYSTEM SETTINGS

To open System Settings, you can use apple > System Settings in the top-left corner of the screen, the Dock icon or the Launchpad. Or you can control-click on the Dock icon and go straight to the Settings window you need.

2 CHECK YOUR APPLE ID

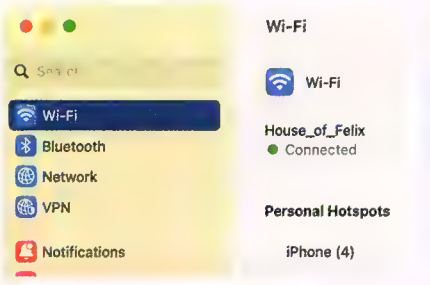
Click your name at the top of the left-hand sidebar to access your Apple ID settings. Click the photo to change it for a Memoji, a picture or another photo. You can set up a Family Sharing account from here too.



3 MONITOR DEVICES

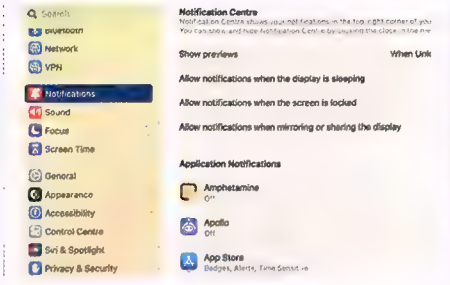
Below your Apple ID settings is a list of all the devices currently logged into it. Click on a device for information such as its serial number, what OS version its running and more. Sign out of your Apple ID at the foot of this window.

CONTINUED... CONFIGURE YOUR MAC IN SYSTEM SETTINGS



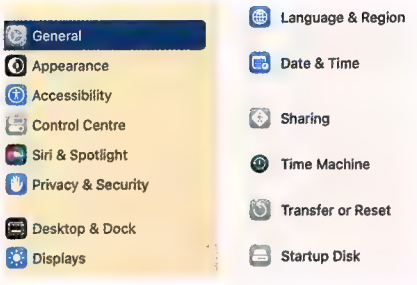
4 NETWORKING SETTINGS

This cluster of settings is for networking. Use Wi-Fi to manage your wireless internet, Bluetooth for pairing your Mac with wireless peripherals, Network for other connectivity options and VPN for a Virtual Private Network.



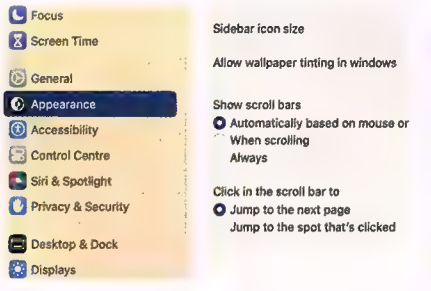
5 NOTIFICATION CHOICES

Here you set up your Notifications options, as well as configuring your Focus preferences and Screen Time features. Under Sound, you can change your alert sound, set up external microphone and speaker options and more.



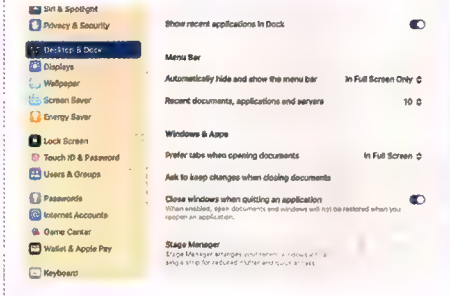
6 GENERAL BUT IMPORTANT

The General System Settings page is one of the most important. It's here you go to update your Mac's operating system, as well as managing log-in items, transfer your data to another Mac, manage your storage and more.



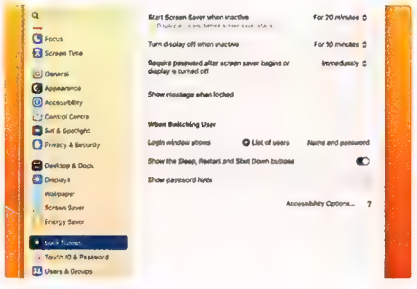
7 MORE OPTIONS

The rest of this cluster controls your Mac's appearance – Control Centre, Siri, Spotlight and Privacy & Security. Under Accessibility, you can configure your Mac to be easier to use to support vision, hearing, learning needs and more.


Show recent applications in Dock
Menu Bar
Automatically hide and show the menu bar
In Full Screen Only
Recent documents, applications and servers
10
Windows & Apps
Prefer tabs when opening documents
In Full Screen
Ask to keep changes when closing documents
Close windows when quitting an application
Stage Manager

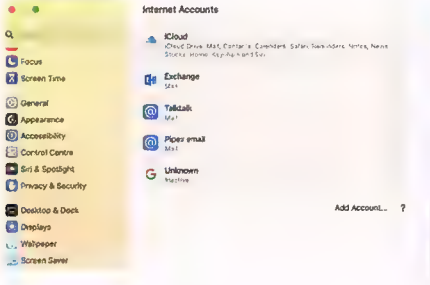
8 VISUALS & SAVERS

Familiarise yourself with these; they're fun. You can change your desktop pattern in Wallpaper. Desktop & Dock is packed with customisation options, and the Displays section is great for getting more from your screens.



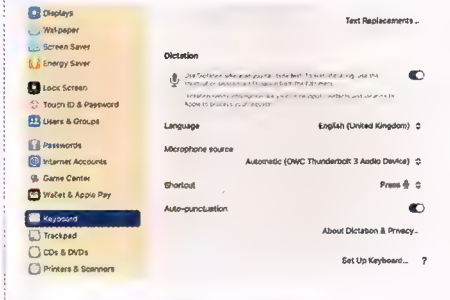
9 PASSWORDS & USERS

Your Lock Screen is where you sign in when you boot your Mac. Configure it here, as well as setting up your Mac's password and, if you have it, Touch ID. This is where you go to add more users and set up guest access too.



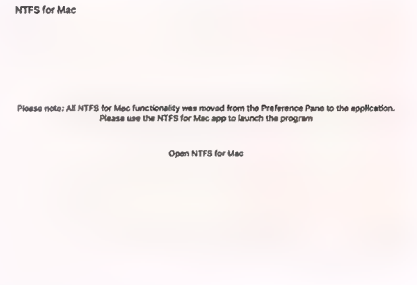
10 INTERNET THINGS

All passwords you've saved from logins on websites can be managed and retrieved in Passwords. Internet Accounts covers things like iCloud, Google and your ISP's email. And you can manage payment options in Wallet & Apple Pay.



11 HARDWARE CONNECTIONS

You can manage any hardware you have connected here. This includes your Apple keyboard, mouse and/or trackpad, along with optical drives and printers and scanners. Check battery levels, set options and more.


NTFS for Mac
Please note: All NTFS for Mac functionality was moved from the Preference Pane to the application.
Please use the NTFS for Mac app to launch the program
Open NTFS for Mac

12 THIRD-PARTY APPS

Apple's System Settings no longer includes any third-party apps that you have installed. Here we can see that see Paragon Software's NTFS for Mac's preferences, functions and options have been moved to the app itself. ■

LINUX

Improve your typing

Years ago, when Shashank Sharma had more hair on his scalp than cheeks, he decided to master touch-typing. With these tools, so can you.

QUICK TIP!
The colour scheme on your terminal emulator can affect the display of these utilities, and you can also experiment with their own colour schemes as well.

Touch-typing is the ability to type without looking at the keyboard. At the very least, this requires you to be familiar with key placements, but more importantly, it takes a lot of practice to be able to type without too many mistakes. Another coveted typing skill is the number of words you can type in a minute, referred to as words per minute (wpm). Apart from various graphical tools and websites designed to help you improve your typing skills, you'll also find various games aimed at children to help familiarise them with the keyboard.

However, if you want to get better at touch-typing and even improve your wpm standing from the comfort of your terminal emulator or CLI, try your hand at these wonderful utilities that are designed to improve your prowess with the keyboard.

The oldest project on our list is GNU Typist, which was first released in 2002. The latest release, version 2.9.5, was published in 2014, but don't let that deter you – GNU Typist is an excellent typing tutor. However, if you prefer newer projects, Ttyper, TT (see below) or Thokr might suit you better.

In addition to the English language, you can also use these tools to master other tongues, such as Spanish, and even programming languages such as Rust, PHP and others.

Learning with GNU Typist

Many distros carry GNU Typist, or Gtypist, in their software repositories. If your distribution is the rare exception, that's all right. Head over to the project's website (**www.gnu.org/software/gtypist/**) and grab the latest tarball. You'll have to extract files from the tarball and then manually build and install it using the **./configure**, **make** and **sudo make install** commands.

> "Apart from various graphical tools and websites designed to help you improve your typing skills, you'll also find various games aimed at children to help familiarise them with the keyboard."

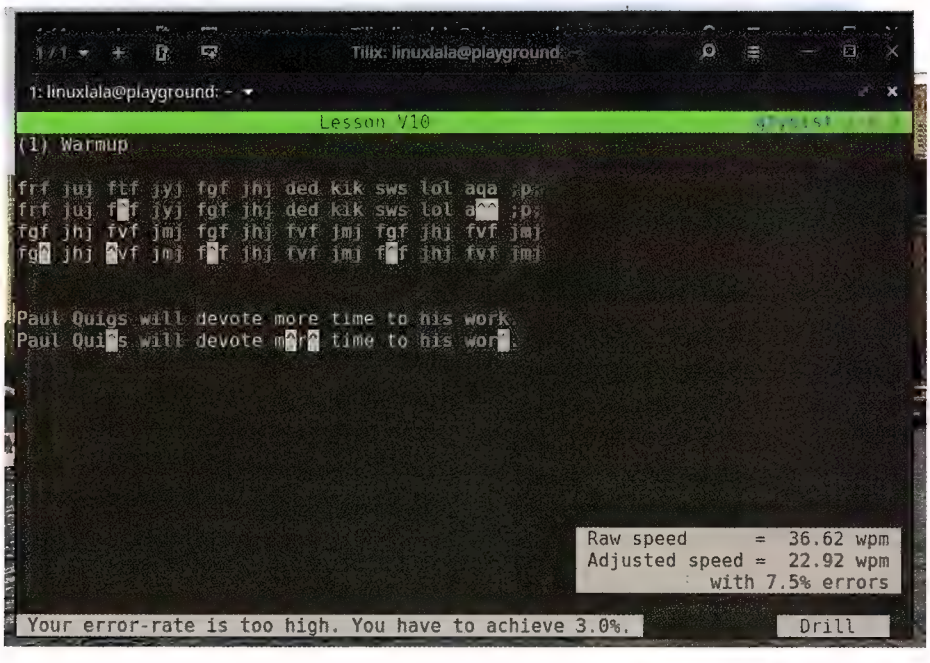
You can now start Gtypist with the **gtypist** command. Unlike the other projects, which supply a list of 100 or 1,000 commonly used words and have you practise typing them as fast as you can, Gtypist is a typing tutor and ships with a variety of tutorials to help you master the keyboard.

If you're a novice who's never made any attempt at touch-typing, Gtypist is the only utility for you. Spend enough time with it, and you can eventually make your way to the other tools, although if you're diligent with your lessons, you might not even need the other tools.

You can begin with the basic QWERTY course to get acclimatised with the keyboard before moving on to the longer QWERTY course and finally the touch-typing QWERTY course. There are other typing and speed drills as well. For non-English speakers, Gtypist features lessons in Czech, Spanish, Russian and others.

When you first run Gtypist, you're greeted with a selection menu that lists 10 series of lessons. Choose one, such as Typing Drills, which has 11 lessons in all, or Speed Drills, which has four lessons. After completing each lesson, Gtypist informs you of your Raw Speed and Adjusted Speed, and your errors as a percentage. Should you finish a lesson with more than a three percent error rate, you have to repeat the lesson.

Refer to the project's man page or run **info gtypist** or **gtypist -h** for a list of supported command options. For instance, you can tweak the default error rate with the **gtypist -e 4%** command, or invoke the Spanish lessons with the **gtypist esp.typ** command.


Tilix: linuxlala@playground: -
1: linuxlala@playground: -
Lesson V10
(1) Warmup
frf juj ftf jyj fgf jhj ded kik sws lol aqa ;p;
frf juj f f jyj fgf jhj ded kik sws lol a ;p;
fgf jhj fvf jmj fgf jhj fvf jmj fgf jhj fvf jmj
fg jhj vf jmj f f jhj fvf jmj f f jhj fvf jmj
Paul Quigs will devote more time to his work.
Paul Qui s will devote m r time to his wor
Raw speed = 36.62 wpm
Adjusted speed = 22.92 wpm
with 7.5% errors
Your error-rate is too high. You have to achieve 3.0%.
Drill

GNU Typist is a typing tutor that features plenty of lessons and drills. Spend enough time with it, and you'll never mistype again.

Using Ttyper

Written in Rust and released under the MIT licence, Ttyper is one of the most popular tools designed to help you master the keyboard.

You won't find it in the repositories of desktop distros, but if your system's already set up for

WORKING WITH TT

Unlike the other tools here, TT is written in Go and not available in the software repositories of distributions. The project publishes a pre-compiled binary, which you can download from the project's GitHub page and place it in any directory in your $PATH to start using it:

```
$ curl -L https://github.com/lemnos/tt/releases/download/v0.4.2/tt-linux -o ~/.local/bin/tt && chmod +x ~/.local/bin/tt
$ sudo curl -o /usr /share/man/man1/tt.1.gz -L https://github.com/lemnos/tt/releases/download/v0.4.2/tt.1.gz
```

The **curl** command is used to download the pre-compiled binary, and we place it in the ~/.local/bin directory and make the file executable. The next command is optional, but recommended if you wish to read the man page.

When you run the **tt** command, the project displays a list of 50 common words. After you type them all, TT reports your wpm, cpm (characters per minute) and accuracy, as well as show a list of words that you mistyped.

You can also run the **tt -quotes en** command if you would rather practise typing popular quotes instead of random words. Use the **-n** command switch if you want to specify the number of words, such as 10 or 20 instead of the default 50. You can also combine this with the **-g** command switch. For instance, the command **tt -n 20 -g 10** displays 10 groups that contain 20 words each. The test is completed only after you've run through all the groups.

Cargo, the package manager for Rust packages, you can install it with the **cargo install ttyper** command. This command installs Ttyper in the ~/.cargo/bin directory. Make sure to add this directory to your $PATH.

If you don't wish to use Cargo, the project publishes pre-compiled binaries for various architectures and platforms. Head to the Releases page on GitHub (**https://github.com/max-niederman/ttyper/releases**) and grab the package that best suits your system. Make sure to click the Show All 23 Assets link at the bottom for a complete list of releases. Next, grab the ttyper-x86_64-unknown-linux-gnu.tar.gz tarball. You must run the **tar xvf ttyper-x86_64-unknown-linux-gnu.tar.gz** command and then move the ttyper binary into a directory in your $PATH:

```
$ tar xvf ttyper-x86_64-unknown-linux-gnu.tar.gz
ttyper
$ mv ttyper ~/.local/bin
$ chmod +x ~/.local/bin/ttyper
```

You can now launch Ttyper with **ttyper**. When run without any command options, Ttyper displays 50 of the 200 most common English words. The top of the interface is for Input, displaying words you type. Below this is the list of Prompt words. Each one is highlighted and you move to the next by pressing Space.

Each correctly typed word is shown in green, but if you mistype a word, it turns red in the Prompt list. Once you've typed all the words in the Prompt list, Ttyper displays a graphic along with an overview of pertinent information, such as wpm, number of correct keypresses and accuracy. Based on the mistyped words, the tool also displays the keys you have most trouble with in the Worst Keys column. For instance, in successive tests, this author had trouble with I.

The graph is window dressing, albeit quite welcome, but we especially appreciate the information about problem keys.

When you've run several of these default tests, you can run the **ttyper -w 100** command to test yourself against 100 of the 200 most common English words. You can similarly use the **-l** command switch to define a different language. For instance, run the **ttyper -l english-advanced** command to test your skill against uncommon words such as bemingle, gastronomists, sluttishnesses, saccharides, hieroglyphic and others. Don't be alarmed if you find your wpm to be drastically reduced after running the advanced test.

You can also set the language as **spanish**, **rust**, **ukrainian**, **ruby**, **qt**, **portuguese**, **java**, **javascript** and so on, if these are the languages you type the most. Run the **ttyper --list-languages** command for a list of all the languages you can practise with Ttyper.

You have to edit the ~/.config/ttyper/config.toml file manually if you wish to change the default behaviour, such as colours.

Thokr is another typing tutor written in Rust. The project admits to being inspired by Ttyper, and it has a similar feature set. You can install it with the **cargo install thokr** command. Run the **thokr --help** command for supported command options. It's quite similar to Ttyper, so you won't feel at sea when trying your hand at it. Refer to the box (bottom-left) for details about the final tool in our list, TT.

Even if you're someone who's been typing for decades, unless you've had professional typing lessons, you'll quickly realise there are some letters that you fumble with, which break the flow when you're typing. With enough time, these tools can help you work through these problem words. ■

PI

Design and build a Pi robot

In his latest series, Les Pounder explains how to plan, design and build your very own Raspberry Pi robot from the basics up.

YOU'LL NEED THIS
- Robot kit
- Soldering iron and accessories
- Flush cutters
- Safety goggles
- Screwdriver

PROJECT! PART 1 OF 3

As a kid, I loved robots. From Robbie the Robot and Metal Mickey to the Terminator and the robots from The Black Hole, if it had a CPU and a tendency to run rampant and threaten the destruction of the world, I was there. Now middle-aged, my love of robots has never waned, but I would rather see them as companions than overlords bent on our destruction.

Robots are still awesome and over the past decade they have become easier and cheaper to create, largely thanks to the Raspberry Pi and Arduino. Building a robot is a right of passage for an aspiring maker. By building your own, you learn key maker skills: soldering, circuits and code. If you have the means and skills to do so, you can go DIY and build a fully custom robot from scratch, using laser-cut or 3D-printed parts. But if starting out, you can use one of the many kits available.

If you want a completely ready-to-go solution, Pimoroni's Trilobot is an amazing kit. Using PCBs as the chassis, this kit integrates the Raspberry Pi 4 as a central part. It can work with ultrasonic sensors, line-following sensors and many others via the GPIO.

At the other end of the robotics scale are the advanced robots that use machine learning and artificial intelligence along with sensors and cameras to understand the world around them and navigate. The best examples of this are the robots from Boston Dynamics, and to a lesser extent the robot vacuum cleaners that keep our homes clean.

The focus of this new series is to create our own four-wheeled robot. Each month, we shall learn more about a specific aspect of the project, starting in this issue with the various types of robots and chassis, and building a chassis on which we will add motors, sensors, Raspberry Pi and a power supply. Later in the series, we shall learn how to give our robot vision and stream live video as we drive around. With that in mind, let's take a look at the basic robot archetypes.

Balancing

Difficult to build, but my word, they are rewarding to see in action. With actions that resemble a person riding a unicycle, balancing robots are typically two-wheeled and use an inertial management unit (IMU) to determine their balance. The brains of the robot take the IMU input and send correction movements to the motors, causing the robot to twitch. Getting this robot running is hard work, and you need good code to keep it upright. Moving around is fun – just remember to cancel the inertia when moving, otherwise your robot looks drunk.

Two-wheeled

A two-wheeled robot is the classic first robot type that many Pi makers come across. Typically designed with two wheels along the centre to provide basic motion and directional control, these robots use a trolley wheel at the rear for balance. These are cheap and easy to build, using nothing more than a motor controller and battery, it is ideal for beginners.

Four-wheeled

You can probably guess that four wheels are better than two. Using the same chassis as the two-wheeled robot and an additional motor controller, we can create a powerful robot capable of overcoming many objects.

Six-wheeled

This type of robot merges the power of a four-wheeled robot with a tracked robot. They aren't usually very fast, and often need low-speed high-torque motors, but with six wheels, your robot is unstoppable. Pi-Borg's DiddyBorg is an example of this kind of robot and just one look tells you that nothing will stop it.

Tracked

Tank tracks are slower than wheels but you can go nearly anywhere. The tracks lay a path for the wheels to tread and nothing gets in the way. Tracked robots are often used in 'sumo' competitions, where small, powerful robots attempt to push one another out of a ring.

Robotic arms

We've all seen robot arms in factories and assembly lines. Debuting in the late 20th century, these robots automated

The starting point for our robotic adventure. A simple, expandable chassis that we can use as the basis of a multi-purpose robot.

our factories to fuel the growth of the era. Our cars, planes, even food are often created using a robotic arm in the process.

Bipedal or quadruped

Making robots with legs is difficult, just ask Boston Dynamics. We take for granted how easy it is for us to walk and move with little thought. For a robot, we need multiple sensors (inertial management units, accelerometers and pressure sensors are just a few) to determine the position, speed and amount of force on a limb. The classic example of a quadruped robot is Boston Dynamics' Spot. The four-legged robot traverses the terrain with ease, but in reality it is constantly scanning for obstacles and people, while following a path.

Chassis

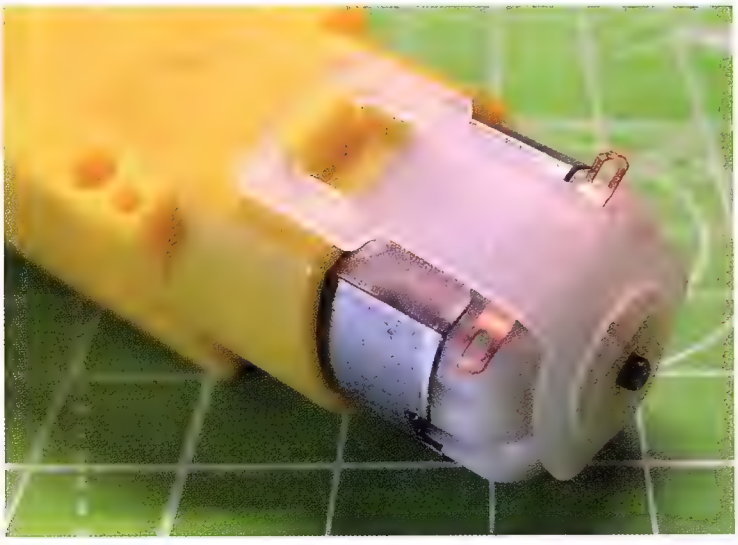
The many types of robots mean there are multiple types of chassis, from a basic two-wheel robot with a trolley wheel, to monster six-wheel-drive behemoths that can conquer any terrain. What is common between all the various chassis types are connection/mount points for our components. So, our first consideration is: what type of robot will we build? Two-wheeled robots are the easiest to make and need the absolute minimum of components, which means our costs are also low. The problem with this robot is stability – if the mass of the robot is too high, it will flip, kick and lean too far. A six-wheeled monster is stable, but it requires a significant investment of time and money to realise. The compromise is a four-wheeled robot, with each wheel being individually controlled using appropriate motor controllers.

Our robot needs connection points for the four motors, the Raspberry Pi, motor controllers, power supply and sensors. This also means that we need to be clever with their placement. With this in mind, a wide base and a double-decker approach is the answer. By creating a hollow between the two decks, we gain double the space and, more importantly, we lower the height of the robot's mass. We now have the bones of a stable and powerful robot. We just need to build it.

So, do we head off and buy a kit? Well, yes, but let's think this through. Do we want plastic, acrylic or metal? Do we want to 3D-print the chassis? A 3D-printed chassis is the ultimate in customisation. We can tweak the chassis to meet our needs, right down to sensor placement and custom mount points. The downside of 3D printing, as wonderful as it is, is time. You can modify existing models to suit your needs, which buys you some time, but printing the chassis can take a day. Don't get us wrong, 3D printers are wonderful and we encourage you to try them out at your local hackspace. But right now, let's stick to a kit.

So, now we are left with the decision of metal or plastic. Plastic is cheap and acrylic chassis have strength and rigidity, but when they break,

Our kit is simple, comprising two acrylic pieces connected using M3 stand-offs and some additional acrylic bits. The four DC motors use mecanum wheels for fluid movement.



The DC motors have two terminals which are used to power the motor from a motor controller.

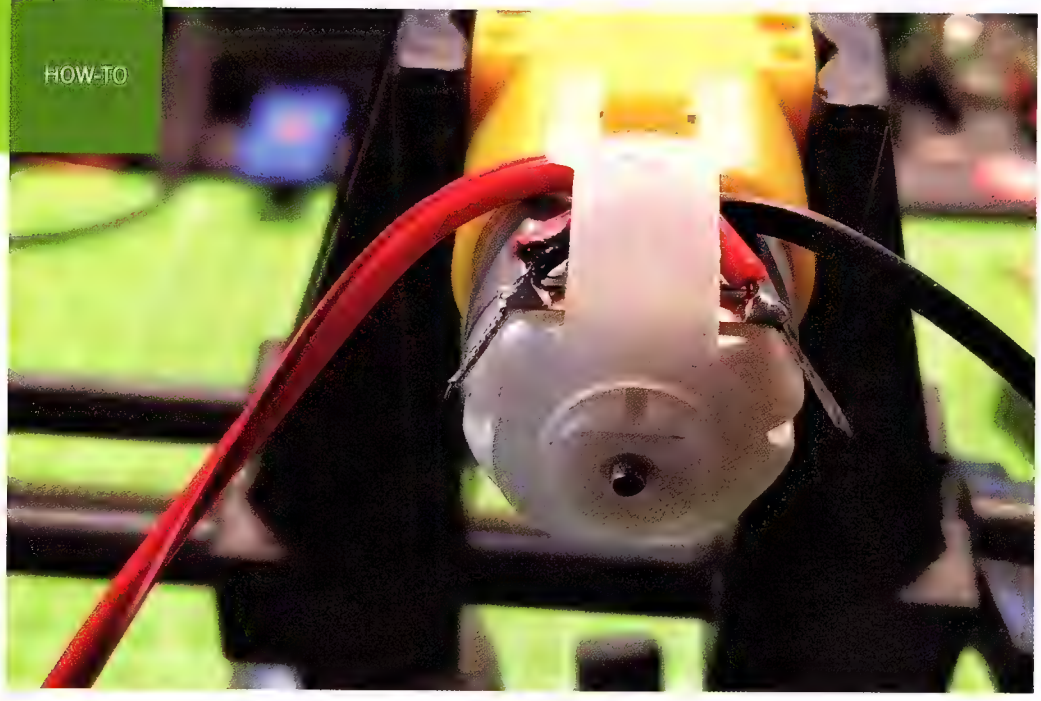
GENIUS TIP!

Acrylic is strong, but brittle. Don't over-tighten any screws, and support areas that you are working on. If it cracks, use a little tape and superglue to reinforce the break. Acrylic shards are sharp, so take care.

RASPBERRY PI KITS

At the start of the tutorial, we alluded to other robot kits, of which there are hundreds. Some are great, others not so. If you are starting out, Pimoroni's Trilobot (**www.tomshardware.com/reviews/pimoroni-trilobot**) is a bulletproof starter kit. Yes, it is rather expensive, but all the complexities are removed for a smooth and fun experience. Trilobot is a two-wheeled robot, with a ball bearing trolley wheel at the rear. Up front there is an ultrasonic HC-SR04 sensor, one of the newer 3V compliant variants, which removes the need for a voltage divider. The chassis is made from PCB material, essentially offering strength and turning the robot into a large HAT to which the Raspberry Pi directly connects.

If you look on Amazon, eBay and so on, you'll find plenty of robot kits. Most are designed to work with the Arduino and Raspberry Pi. Just make sure if purchasing a kit that it works with the Pi. Typical kits are like the one we use in this issue. They offer the chassis and motors, along with fixings that we can use to build the robot. Other kits come with a motor controller. We'll go into more detail about these next month, but generally an L298D, L9110S or DRV8833 is supplied, all of which are exceptionally easy to work with.



Soldering the wires to the terminals is simple – just take your time and watch out for the plastic parts. We tuck the wires under a plastic clip to add strain-relief to the wires.

they often leave a sharp shard. Metal is strong and light, but it can be expensive. If you are planning to go off road with your robot, metal is the best option. It can take the knocks and still come back for more action. Acrylic is the best compromise for a general-purpose robot, and we can mitigate the chance of damage with some well-placed bumpers. We can also easily add mount points by using a drill to carefully make holes in the acrylic. We can also do this with metal, just take it slow and wear the appropriate safety glasses.

Building the chassis

To build the chassis, we need a few tools. A screwdriver and soldering iron kit are necessary. The screwdriver is used to secure the chassis using machine screws and M3 pillars. The soldering iron is necessary to solder wires to the motor terminal. Some heat-shrink tubing can also come in handy to tidy up and reinforce the solder joints.

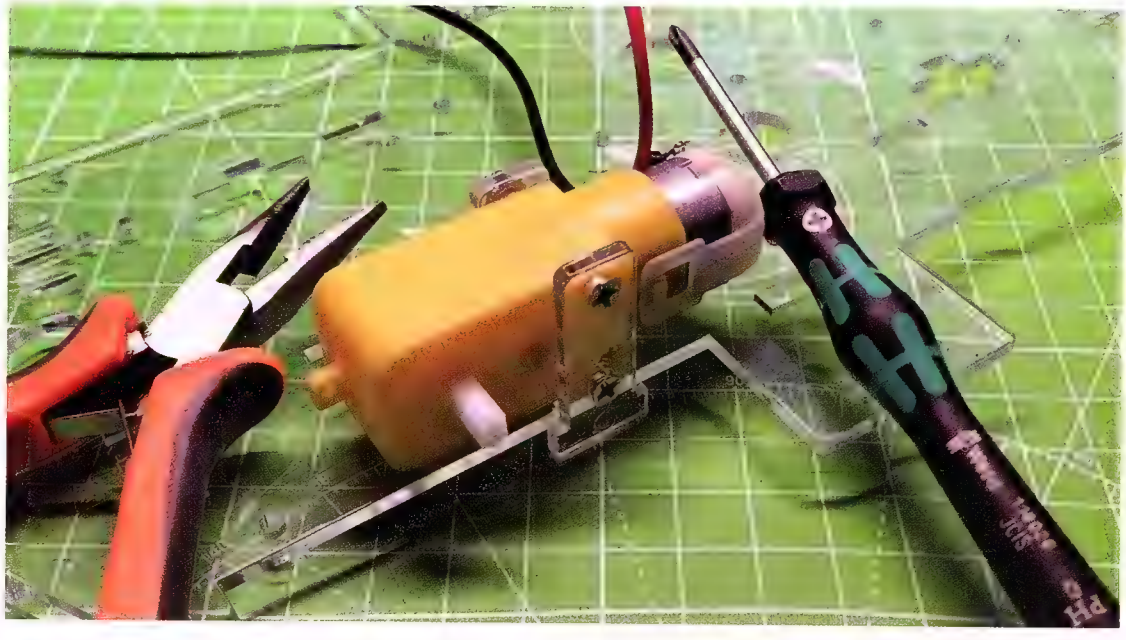
The first step is to solder wires to the motors. Each motor has two terminals – by applying power in one direction, the motor spins; reverse the power flow and the motor spins in the opposite direction. The flow of power is controlled using a motor controller, itself controlled via the Pi's GPIO. Soldering the wires to the motors is simple. First, use wire strippers to strip approximately 5mm from the end of the wires. Gently twist the exposed wires so they each become a neat spiral. Use some modelling clay or Blu Tack to secure the wires down. Now flow a little solder on to each twist. This locks the twist in place and enables us to make a solid solder joint to the terminal. On the motor terminals, slide the wires under the plastic retaining clip, then thread the exposed wires through the terminals. Add some solder to make the connection. Make sure the connection is secure and there are no solder spikes. Repeat this step for all the terminals.

The next step is to remove the protective covering from the acrylic pieces of the kit. Take your time and be careful. Peeling it all off in one go is rewarding, but you may strain the acrylic too much and cause a crack (we've done it ourselves). With the protection removed, we can now use the screws to secure the motors to the chassis. This differs depending on the kit, so see your instructions. Typically, we have a machine screw and nut that go through the chassis and motor, holding it in place. Use a screwdriver and pliers to secure everything, but don't over-tighten as this could cause damage.

With the motors in place, add the M3 pillars to the lower part of the chassis, then use machine screws to secure the top deck of the chassis. Now we have a chassis with two decks and four motors.

Choosing wheels

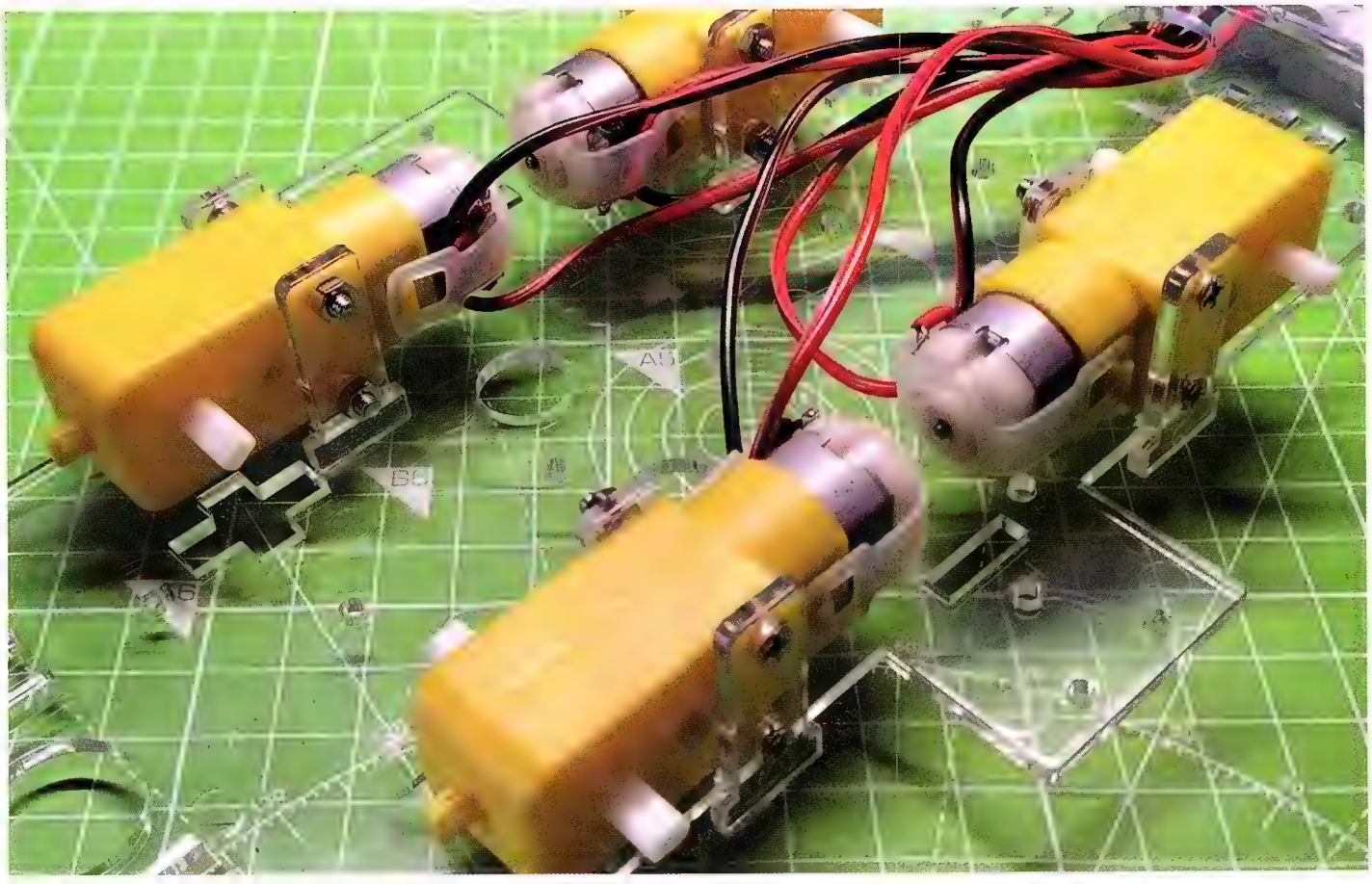
Wheels are the interface between the robot and the terrain. The more grip you have, the better control, but grip also means friction. Tracks offer the best all-terrain experience, but they are slower than wheels. Thick wheels, thin, large



The first motor is held in place using two acrylic stand-offs that are used for mechanical connection to the chassis.

GENIUS TIP!

Tuck the wires from the motors under the plastic collar of the motor. This adds a little mechanical strength and provides resistance should the wire be snagged and pulled.



grooves, smooth? It all depends on what type of robot you are building. A robot running on carpet or wood floors can do just fine with typical road tyres that offer a balance between speed and grip. Going outdoors? Grass and gravel benefit from a more off-road tyre, with plenty of grip for the rugged terrain. Going through mud, sand or marshy conditions? Use a tank track – it spreads the load of the robot across a broader area. What did we choose for our robot? Mecanum wheels. These omni-directional wheels are best on smooth surfaces, such as carpet and wood floors. They look very different from traditional wheels, with the circumference of the wheel seeing a ring of rollers at a 45-degree angle. These rollers can move the robot in the traditional forwards and backwards, and spin left and right, but they can also be used to shuffle the robot left and right, as if the robot were strafing in an FPS game. By turning the motors in the correct direction, the robot can shuffle and navigate around objects. We'll have to use some clever code to accomplish this, but we can do it.

We repeat the motor build process four times. Top tip: secure the motors to finger tightness, then use pliers to add a little more rigidity.

GENIUS TIP!

The screw points on the chassis are M3 sized and that means we can easily add extra connection points for sensors, battery packs and Raspberry Pi. M2.5 and M3 fittings can be easily sourced online.

Connecting the wheels to the motors supplied in our kit was a breeze. They press into place and hold with an aggressive level of friction. When putting on your wheels, take care – the plastic motor supports need to be braced, otherwise they could snap.

Where are we at?

Right now, we should have a double-decker robot with four motors, four wheels and plenty of wires. We're ready to move on to the next step in the process: basic control of the motors. That will be in the next issue. We'll cover how to write Python code that will breathe life into the robot and enable us to control the GPIO and in turn control two motor controllers that will direct power from the battery to the motors, causing them to spring into life and move our robot through a series of tests to fine-tune our control. In the issue after that, we will learn how to interface sensors into the robot, giving it the means to navigate and understand its terrain. We then move onwards in further issues, learning how to stream video from our robot, add external controls and tweak the robot for more advanced projects.

Right now, let's take stock and reflect on our handiwork. We have learned how to construct the robot kit using common maker tools. We've also learned a few tricks and gotchas that often hit new roboteers. The future of our robot will see a lot more electronics – and even more Python code. And all of this is made possible by the Raspberry Pi at the heart of our robot. ■

WHAT LANGUAGE IS BEST FOR ROBOTICS?

This is the ultimate question for many programmers. The best language for robotics depends on the use case. If you need speed, a language such as a C variant would be the best option. It is fast and compact, but a little harder for beginners to understand. If some form of C is your choice, perhaps learning the basics with an Arduino-based robot is a good start. The Arduino IDE uses a form of C that compiles into something the board can understand.

We'll be using Python for our robot, but why? The simple answer is that Python is a good all-purpose language, and the Raspberry Pi has exceptional support for it. Python has access to a library of modules containing prewritten code. We can use the RPi.GPIO or GPIO Zero modules to control the motors and read sensors on our robot. Adding video streaming is possible using a Python module; even Bluetooth control is possible. At PyCon 2018, a speaker said that "Python is the second best language" and we agree. It may not be the right solution to every problem, but it offers an accessible entry point to a world where the user can discover the right tool for the job.

GAMES

Dwarf Fortress

Tunnels onto Steam in all its unfathomable glory.

■ $43.95 | PC | bay12games.com

Fehigath Arrowscrapes Metropolis
Pop 198 16 23 38 39 30 25 27
Food Drink Seeds Meat Fish Plant Other
2855 85 1110 1661 24 353 2193
21st Moonstone Early Winter Year 106
PETITIONS
Dense knotgrass
Persimmon leaves
Elevation 49

apc HIGHLY RECOMMENDED

The ever-evolving life's work of brother developers Tarn and Zach Adams, *Dwarf Fortress* is entering a new age, shedding its text-based graphics for proper pixels and the basic modernity of native mouse support. Still inscrutable *Dwarf Fortress* remains a treasure trove of procedural myth-making for those delving into it.

At its most basic level, *Dwarf Fortress* is a settlement sim. With a small group of dwarves, you embark from the Mountainhomes to stake your claim on a plot of distant wilderness. It's up to you to establish a fortress capable of lasting the ages, from the ground up – or down, in dwarven fashion.

At first, *Dwarf Fortress* can be deceptively simple. Clunky to control, maybe, but when you're marking out tunnels to mine and trees to chop it seems easy enough. Within minutes you're three menus deep, trying to parse labour details and work duties, assign administrative positions, designate burrows, organise food, gems, finished goods and wheat ale.

Leaving that delicate balancing act of fortress management aside, the Steam release's most obvious changes are visual. Until now, *Dwarf Fortress* has been an ASCII-based enterprise, requiring mods for any imagery more engaging than a letter 'D' facing you in martial combat.

Now, *Dwarf Fortress* boasts its own lovely tile-based graphics. They're charming enough to look at, your dwarves' physical features realised in sprites. The visual overhaul joins an expanded soundtrack, which moves between the gruff warmth of dwarven work songs, plaintive acoustic plucking, and haunting atmospherics.

> "If you've heard of *Dwarf Fortress*, you're probably familiar with its daunting reputation. It's not unearned."

In terms of playability, the biggest changes involve the interface and controls. Limited before to keyboard input, *Dwarf Fortress* now has mouse support. Clicking to designate/interact with/inspect things is a much-needed and welcome change, but the revision of *Dwarf Fortress*' UX philosophy isn't a flawless one.

If you've heard of *Dwarf Fortress*, you're probably familiar with its daunting reputation. It's not unearned. In building and managing your new mountain home, the game does very little work for you. It's just you, a bunch of menus and whatever ragged scrap of self-preservation instinct your dwarves can muster.

And you will fail. A lot! That's expected. *Dwarf Fortress*' guiding ethos, as the game itself tells you, is that losing is fun. It has no victory condition. There's no winning. In the end, every fortress you make is doomed, whether you're forced to abandon it or choose to.

As ever, *Dwarf Fortress* is a game you have to meet more than halfway. It requires a buy-in: a willingness to teach yourself its rules, to take the details of its generated world building and craft your own mythology. But now, the first steps in exploring its depths are a little easier to take. If you're willing, it's an experience you won't match anywhere else.

A worthy revision of the legendary settlement sim. Slightly less impenetrable, just as engrossing.

Lincoln Carpenter

★★★★☆

CRISIS CORE REUNION

Makes an old story feel brand-new.

■ $74.95 | PC | bit.ly/3v6we1o

In lesser hands the nostalgia unleashed by *Crisis Core* would be nothing more than another case of Remembering Things: The Game. But *Crisis Core* doesn't wallow in the past. The story of Zack Fair and *Crisis Core*'s many other new characters bring with them fresh perspectives, sometimes clarifying old and muddily written plot threads, sometimes adding further intrigue to events that seemed clear-cut and fully explained the first time around.

Crisis Core's origins as a PSP game bring with them an unexpected benefit – brevity. The original didn't have the disc space or battery power to waste time doing anything other than get straight to the point, and thanks to this the main story in *Reunion* keeps moving forwards at a brisk pace with plenty of save points along the way, and a good chunk of the optional content is contained within its own easily accessed menu.

The 3D landscapes cover steampunk slums filled with detailed junk and verdant villages, but only the look and layouts are from the original. Everything else is either brand new or pilfered, perhaps with some minor alterations, from the existing models found within *Final Fantasy VII Remake*.

Crisis Core's old combat system has been almost entirely rebuilt, and definitely for the better. Revamped core commands and an intelligent lock-on system give Zack the fluidity of an action hero, while a range of subtle details add layers of strategic nuance. Many RPG battle systems rely entirely on the power of maths to determine whether an attack hits or misses its target, whereas *Crisis Core* focuses on positioning in the moment instead: blows only causing damage when sword arm or spell meets creepy Shinra-funded abomination.

> "*Crisis Core*'s old combat system has been almost entirely rebuilt, and definitely for the better."

Crisis Core Reunion is a concise and engrossing action RPG with no patience for filler. Zack's positivity in a world designed to crush him still managed to tug at my heartstrings, even though I knew exactly how his story was going to play out before I'd even installed the game.

An excellent remake, prequel, and game in its own right – *Crisis Core: Final Fantasy VII Reunion* has it all.

Kerry Brunskill

★★★★☆

MADVENT CALENDAR 3: NECROSIS

Yule be mad to ignore this.

■ Free | PC | bit.ly/Madvent3

A month of terror awaits you in *Madvent Calendar 3: Necrosis*. Well, terror and a bit of a comedy, and even heart-warming moments. It's another bumper anthology by a gaggle of talented indie devs, who have come together to create 30 short, PS1-style games with a seasonal theme. After opening all 30 doors I'm going to talk about the highlights – and there are some truly impressive games buried in this gift heap.

In The Drink might be my favourite, a *Metroidvania* where you pilot a submersible. The physics of the craft feel spot-on, and it's a joy to explore its underwater sci-fi world, as you swiftly acquire abilities.

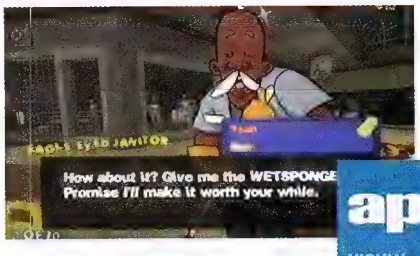
A Mall Near You begins unpromisingly, by dropping you inside a clichéd spooky mall. But then it turns out it's not spooky, just nearly empty and five minutes from closing.

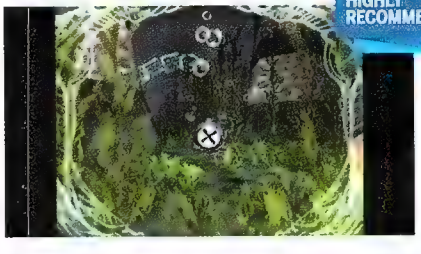
In terms of proper horror your first port of call should be *Truss*. It's an existential horror game with some hugely impressive visual effects, as you roam a cabin and wintry forest in a world that is crumbling around you.

Come and binge on this unsold advent calendar filled with spooky and occasionally delectable treats.

Tom Sykes

★★★★☆





LIGHTHOUSE OF THE DEAD

Remembering the lightgun.

■ Free | PC | bit.ly/LighthouseDead

Lighthouse of the Dead takes me back 20 years: the days of cheesy B-movie storylines, vivid colour palettes, and polygons the size of tortilla chips. It has all those things, but it also has the feel of the classic lightgun games: the smooth, on-rails camera movement, the satisfying weaponry, and the enemies that bound towards you, getting right up in your grill.

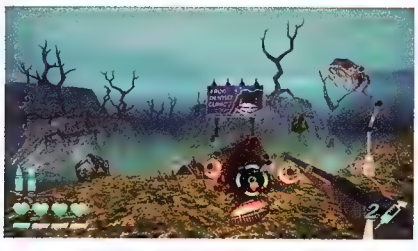
Taking its cues from *House of the Dead*, *Lighthouse* offers a similar journey through a schlocky horror landscape, although the enemies this time are mutant frogs. They leap towards you in a maddening way. I found them challenging from minute one, even after I grew accustomed to their movement, and restarted a couple of times.

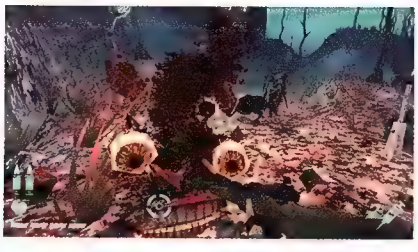
The other enemies are Terminator-esque androids, and appear less frequently, asking you to simply shoot their weak spots. They're a strong couple of enemies, though not enough to keep the game from feeling repetitive. A fully fledged lightgun game would offer set pieces, or shake things up in other ways.

It's a bit too simple, with no weapons to find or power-ups to collect. Just aiming, shooting and reloading gets tiring.

Tom Sykes

★★★⯪☆





IXION

Humanity's survival prospects look dire in this colony-builder.

■ $49.95 | PC, Linux | kasedogames.com/ixion

Developer Bulwark has come up with a compelling premise: what do you do when your experimental vessel accidentally dislodges a chunk of the moon, ending humanity's existence on Earth?

Stranded in the Milky Way, my first concern as administrator of the Tiqqun space station is to ensure the continued survival of the crew and discover what went so wrong during launch. As with similar base-building games, the beguiling enormity of the task ahead is masked by a limited array of starting options: constructing essential buildings like living quarters and infirmaries, designing roads to facilitate transportation between them, and tending to the station's haemorrhaging outer shell, a hull ripped apart by the force of that jump.

It's balanced and calmly elegiac busywork for the first few hours, even if Bulwark decides to keep the training wheels on a bit too long as it schools novice administrators in how to stave off the two major threats: mutiny from an increasingly distressed crew and the hull dissipating into nothingness.

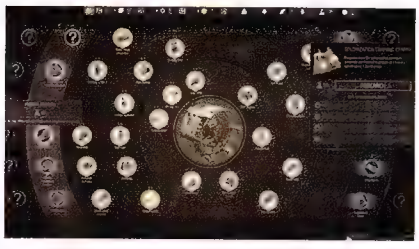
It is at this point, that the game finally opens up with an exciting range of possibilities: an unknown star system to explore and freshly unlocked technologies to research, some of them with important ramifications in the way you manage your colony. New hazards appear, too. A higher rate of work-related accidents and resultant power failures require you invest in resource-draining solar panels and batteries, while the growing displeasure of the crew instils a sense of urgency in your search for the elusive Protagoras lest their despair turns into anger. It's a necessary escalation, as I had admittedly started getting a bit too comfortable by that point, but the game's infuriating tendency to throw every mishap at me simultaneously made the sudden difficulty spike feel artificial and aggravating.

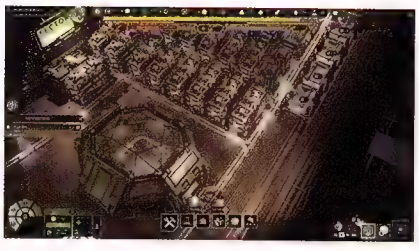
But, the numerous bugs, the long stretches of inactivity, and the disastrous, collapsing dominoes that could ensue from a single omission or bad decision made for a maddening game; one whose biggest obstacles – whether designed or unintended – brought me little joy in overcoming.

Ixion is an enticing premise that's unfortunately held back by uneven pacing and glaring technical issues.

Alexander Chatziioannou

★★⯪☆☆





KYNSEED

A stew made from elements of Fable, Stardew Valley and Crusader Kings.

■ $36.50 | PC | kynseed.com

The problem with a game like *Kynseed* is that it's nearly impossible to actually finish. That doesn't mean there's no end, just that there's such a long time between when you start and when you could finish doing everything the game has to offer. It is a jam-packed game that combines life sim elements from *Story of Seasons* and *Stardew Valley* with Western RPGs like *Fable* and *The Elder Scrolls*, and it pulls both off pretty well.

Apart from chasing down the central narrative, players can choose to play the game any number of ways. There are six distinct skill trees, which cover gardening, cooking, fishing, exploration and melee and ranged combat, respectively. One could conceivably solely focus on their farm, cultivating the land and livestock until every inch of Willowdown Farm is self-sufficient and profitable; they could travel all through Quill in search of secrets and treasures; they could buy a shop in town, focus on starting a family, and create a long and powerful family tree that spans multiple generations. There is no wrong way to play, and this might cause a bit of distress in players used to more structured fare.

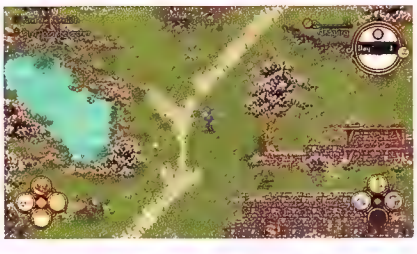
What I enjoy the most about *Kynseed* isn't the complexity of its systems, or the originality of its story. It isn't just the beautiful 2D pixelated art or the way you enter an area and the music shifts from cheerful to elegiac on a dime. It isn't any single interaction with a villager, or relationship built up, or neat secret found. It's the fact that the profound and the mundane mix so well together, how you can be bundling up some radishes for some random guy you met one minute and piecing together a supernatural mystery the next. There are minor stumbling blocks here and there, but if you loved watching the seasons change in *Animal Crossing* or revelled in following a powerful family in its ascendancy in *Crusader Kings*, you will love *Kynseed*.

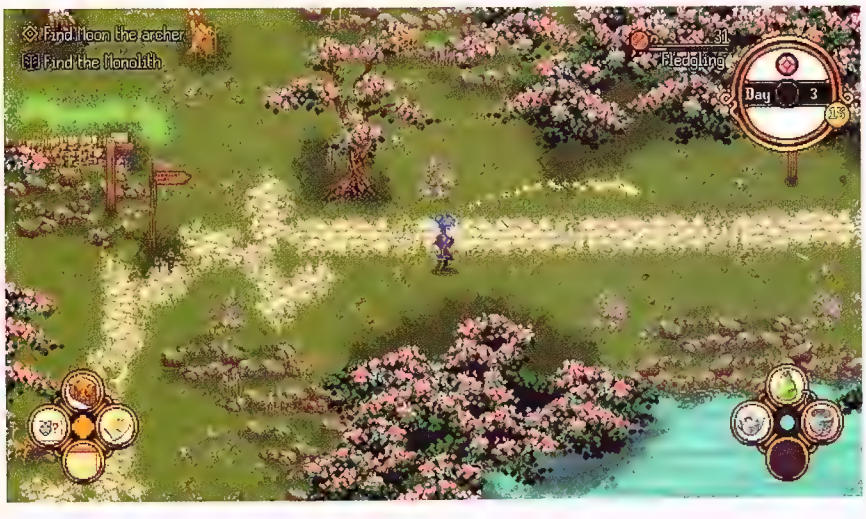
"There is no wrong way to play, and this might cause a bit of distress in players used to more structured fare."

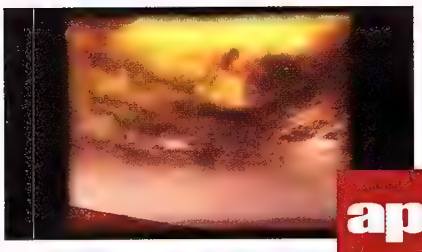
Kynseed is gorgeous, fun, and surprisingly impactful. However, don't rush through the prologue too much.

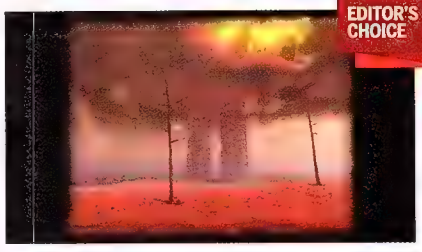
Kaile Hultner

★★★½☆









apc EDITOR'S CHOICE

VERGILIUS

Alone in the afterlife.

■ Free | PC | bit.ly/VergiliusGame

Vergilius feels like a silent movie – an expressionist horror movie, as you traipse around a vivid dreamscape under a churning sky. We're in walking sim territory, so all you really do here is explore and absorb a desert environment. And what an atmosphere to wallow in, even without the narrator unspooling his tale. It feels cold and unwelcoming, but like a landscape you want to chart at the same time.

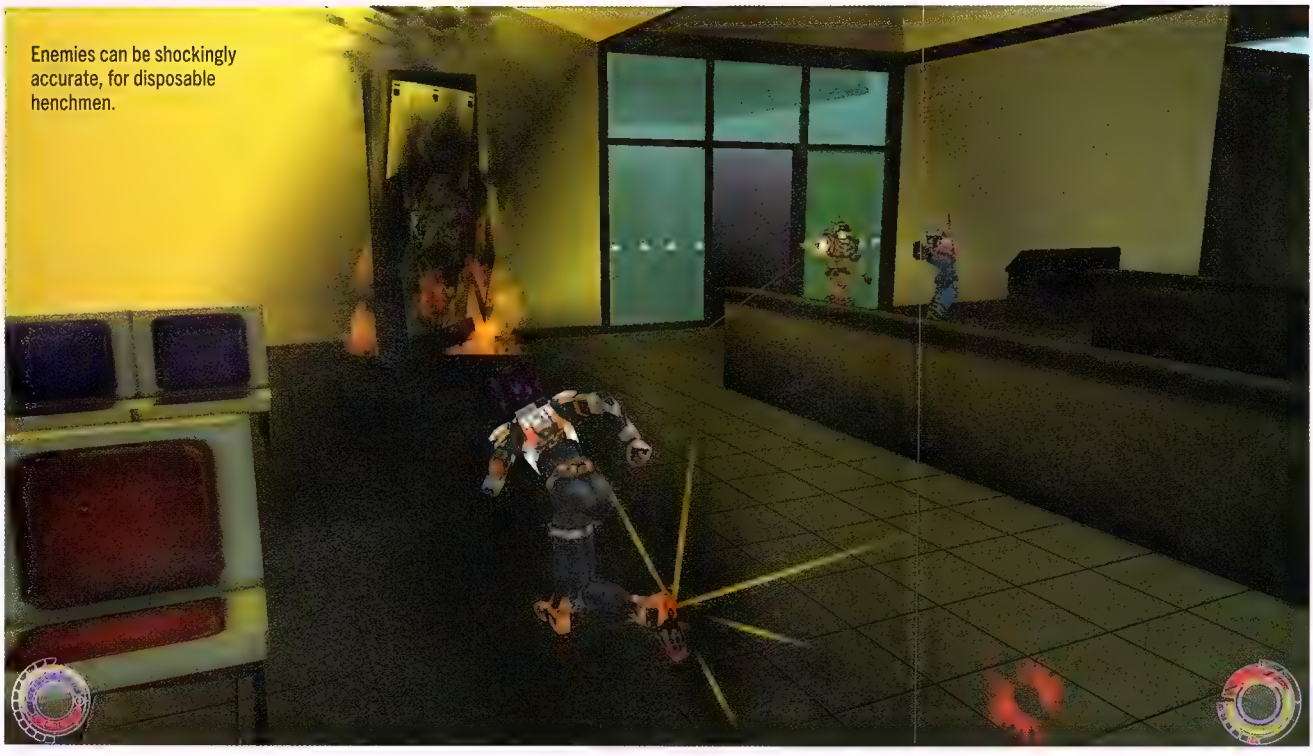
You don't, because things begin to happen: images appear in the desert, including a heavenly woodland and grainy stock footage of your life. Ultimately you're guided towards two towers in the distance, but what will you find there? The text narration recalls Lovecraft, with its account of a nightmarish scenario, but this is a story of a soul in purgatory being asked to make a choice.

Walking sims, really, are games about experiencing mood, while you look around, blinking, in an open space. *Vergilius*' eerily authentic, filmic filter, its canny use of existing footage, and its unreal landscape combine to create a game that feels more like a dream.

A delightfully dreamy walking game with remarkably pretty clouds.

Tom Sykes

★★★½☆



Enemies can be shockingly accurate, for disposable henchmen.

GAME CHANGER

ONI

A brawling action adventure that deserves a second chance. By Samantha Greer

■ **Release:** 2001 **Developer:** Bungie **Publisher:** Take-Two Interactive **Link:** bit.ly/3VdRygj

Oni is not, in its entirety, a particularly good game. It just so happens to contain one or two great things. Released just ten months before a true landmark game, *Halo: Combat Evolved*, it paints a picture of astonishing innovation in such a short period of time. *Oni* feels half rooted in the games of the previous decade, *Tomb Raider* especially, while *Halo* would go on to usher a new definition of what mainstream action games could be.

On the face of it, *Oni* is a clear *Ghost in the Shell* knockoff, an attempt to capture the essence of the 1995 anime classic. It isn't really successful at all, evoking neither the melancholy tone or its dense, fully realised world, nor transporting the film's action into videogames. In fact, I am shocked that no game has ever really brought *Ghost in the Shell* fully into the virtual world. Pieces of it are so influential throughout the whole medium, but the whole eludes the cyberpunk worlds and sci-fi action titles which fixate on bolder, shinier things that are a world away from the understated anime.

Major influence

The game isn't precisely a straight rip-off. It reassembles ideas and components into Bungie's own, much more cartoonish and camp version of a dystopian future. It must have seemed quaint back in the early 2000s, to suggest the planet would become a largely uninhabitable, polluted catastrophe in the year 2032. Now, with that time less than a decade away, the future of *Oni* feels less like an edgy premise and more an ever-present reminder of a fast-approaching nightmare. That the crisis we are living through permeated culture decades ago, long before the effect had fully begun to be felt. It's bleak in a way the camp action tone of *Oni* doesn't reflect, but playing it in 2023 gives the game a distinctly gloomy vibe. And, by god, is it a gloomy game. Literally. Despite the purple-haired protagonist, the world of *Oni* is largely defined by the colours grey and beige, like being trapped inside the case of a '90s Dell computer.

Anyway, forget about all that because it's so much fun to kick and punch lads. If there's only one thing Bungie sought to translate into a game from its inspiration, it's that scene where Major Motoko Kusunagi beats the living crap out of a shooter. It didn't bother with the optical camouflage (despite some very slight stealth options) that made the scene iconic, but that's OK because it made the beating up part really fun.

Combat evolved

Even in 2023 the combat is still an impressive thing to grapple with, using only a handful of buttons in combination with movement and timing to provide you with a whole suite of ass-kicking. On left-click you have punches, right-clicking gets you kicks. You can do flying kicks, crouch to sweep someone's legs out,

Everyone shouts their special moves aloud because they're cool.

sprint and punch for a tackle, punch as you stand up to get a devastating uppercut special... there are moves upon moves tucked into this. Even the dodging has a range of possibilities, from rolls to backflips. All of this is tied together with animation that's still kinda spectacular 20 years on. How smoothly it transitions between different moves and different directions makes it as fun to watch as it is figuring out how to tackle baddies. There's even a taunt button so protagonist Konoko (voiced by Amanda Winn-Lee of Neon Genesis Evangelion fame) can yell, "You're about to be beaten by a girl," at her foes, in a hokey but entertaining attempt to declare her as a 'strong female protagonist'.

You're not alone either, with allies and civilian NPCs cropping up in missions to engage in set-pieces or offer assistance. Never more memorably than the random airport workers who helped me beat up an army of cyberpunk pro-wrestlers. The AI is surprising as well. Enemies and allies alike will pick up a weapon should they be disarmed, or trade their current gun for a better firearm if one should be lying around. It's dynamic in a way that doesn't necessarily cohere with the game's core loop, but showcases the first step towards Halo's much more impressive battles.

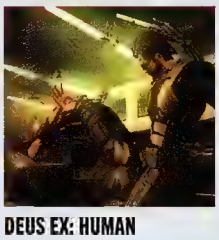
There are guns too. Some impressive ones, like a 'screaming launcher' that releases a literally screaming projectile that homes in on enemies, killing anything it touches. My personal favourite was the sniper rifle which fires super-heated mercury... for some reason. I dunno, it's just cool. Firearms are, however, not the fun part at all. They're clunky to use by today's standards and difficult to aim as well. No, you want to get in close, kicking guns out of enemy hands before dishing out furious justice.

CYBER-FLUNK

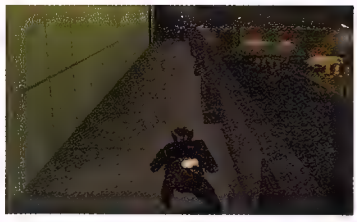
Ghost in the Shell knockoffs

NEOTOKYO
A standalone mod and multiplayer shooter that borrows from the 1995 classic. The soundtrack is still lovely listening.

CYBERPUNK 2077
While containing a wealth of influences, *Ghost in the Shell* is present in much of the open world RPG, from weapons to locations.

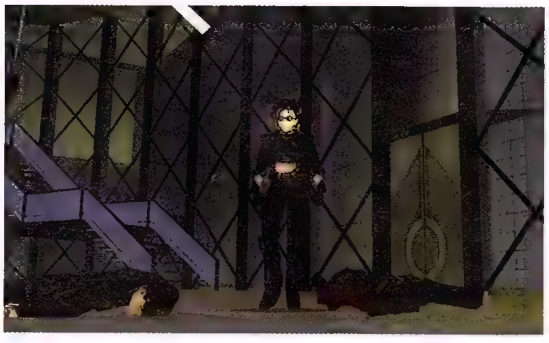


DEUS EX: HUMAN REVOLUTION
The original might owe something too, but it's here where you really get to be a reluctant murder-cyborg.



Above: Not every level is as bland as this but they don't get much better.

Right: *The Matrix* just came out and this was (is) still cool.



This combat makes me long for a follow-up, a sequel or spiritual successor, that updates it. It's not *Batman Arkham Asylum* simplicity but neither is it the full-fledged complexity of a proper fighting game. Sitting comfortably in the middle of that spectrum, it has depth without getting bogged down in memorising button presses, managing to stay intuitive in spite of the wealth of options. There's not really anything else quite like it. Besides, *Oni* has problems in almost every department that get in the way of that delicious core.

Master Chief complaint

Though the story isn't the worst offender. It's got twists and turns telegraphed so well they could be broadcast from one of those skyscraper-sized billboards in *Blade Runner*, and it takes until well after the halfway point before anything really starts to happen. Yet there's a charm to the voice acting, as well as the characters, channelling quite obviously *Ghost in the Shell* but also a little *Akira* too. Neither does the soundtrack nor the sound design let the game down, though it is amusing how many sound effects would be recycled for *Halo: Combat Evolved*. If you played *Halo* first like I did, coming to *Oni* is a strange experience. Like stumbling upon a cancelled prototype of a direction not taken for the game you know.

Unfortunately, there is a lot else that just does not work about *Oni*. Checkpoints that are ludicrously far apart, destined to lose you what can feel like 20 minutes' worth of progress upon death. Awkward platforming, a victim of early 3D not yet compensating for the shift in perspective. Then there is the repetitive level design (despite some impressive spaces around the mid-game) that isn't helped by a lot of endless grey corridors and a reliance on medikits to restore health, grinding the game down into something tedious. It's all too easy to get stuck in a rut where you're low on health and there's no medikits available but an army of goons

to face, who all have whatever the opposite of stormtrooper aim is. Some are flaws Bungie would address only a few months later in *Halo*, introducing a recharging shield as well as a smarter, more frequent checkpoint system that would ensure players never found themselves in a dead end or losing heaps of progress.

In that sense *Oni* is an interesting time capsule, a stepping stone between early 3D titles and those whose influence are still readily apparent today, 20 years on. As I've already said, it's crying out for a new iteration. Something with a livelier world and fleshed-out mechanics around the dexterous combat. That combat though. To still be enjoyable this many years on is truly a feat that makes *Oni* worthy of a revisit. You'll need to get a hold of the *Anniversary Edition* mod to make the most of it on modern hardware, but it's worth the minor faff. Though I doubt you'll stick around to see the credits roll. ■

RETRO

Floppy disks: the technology that won't die

For many, a floppy disk is just a save icon, but don't press the eject button on the real deal just yet. The storage medium is still in demand, finds David Crookes.

Popular perception suggests that Japan is at the cutting-edge of consumer electronics, robotics and aerospace research. It's also a country where you can whizz around at high speed on a bullet train then sit on a toilet that checks your blood pressure before cleaning the bowl.

In that sense, you'd think it would have no trouble letting go of the past. So when Japan's government ministers finally called time on floppy disks, the world was surprised. Surely they had disappeared from the land of the rising sun many moons ago?

As it turned out, the country has more than 1,900 regulations determining how data should be shared, and loads of them still require the use of floppy disks. It led a perplexed Taro Kono, Japan's minister of digital affairs, to enquire: "Where does one even buy a floppy disk these days?" But it would seem that Japan is not alone in having a long-term love of this particular storage medium.

Rewind to the mid-1990s and it's fair to say that everyone used them. The floppy disk was at its peak, with more than five billion being sold worldwide and barely an office worker or student leaving the house without one in their pocket. But in 1998, Apple announced it was ditching the floppy disk drive when it released the iMac G3. The writing was on the wall from that moment on.

Above: Floppies are still being sold in surprisingly large numbers.

In fact, by March 2011, just 12 million 3.5in floppy disks were being sold each year in Japan, the medium having given way to rewritable CDs and USB sticks. Sony, which had a 70 percent share of the floppy market, decided this simply wasn't enough, so it ceased sales of a format it had introduced in 1982, effectively sending it the way of the 8-track.

It was at that stage, however, that a former tax lawyer called

"Rewind to the mid-1990s and it's fair to say that everyone used them. The floppy disk was at its peak, with more than five billion being sold worldwide and barely an office worker or student leaving the house without one in their pocket."

Tom Persky snapped up a couple of million disks, boosting a floppy disk collection that was already sizeable. His intention was to continue selling them, and today he has about 500,000 left while proclaiming himself to be the "last man standing in the floppy disk business". If Kono wants to buy a batch, then he need look no further!

Persky's floppies are stored in a warehouse in Lake Forest, California. As well as 3.5in disks, Persky also has 5.25in and 8in varieties, and they form the stock for a business called **floppydisk.com**, which has been around for more than two decades (the domain having been snapped up for $1,000 in the early days of the internet when Persky was running a floppy disk duplication business).

Each day, he sells roughly 500 disks, which equates to more than 130,000 each year. Sure, it's a far cry from the big numbers of the 1990s or even 2011, but it's still perhaps surprising. "It's a big world out there, man," the 73-year-old said when we expressed our astonishment at the numbers. "People want floppy disks and I probably get about 20 orders for blank disks each day."

Flexible medium

There are many reasons why floppy disks are still being used. Persky points to them being a storage medium for many healthcare computing devices, for instance, and they're also used in avionics. The US Defense Department had stashes of them as recently as 2019 despite their limited capacity ("you could fit *War and Peace* on one but not a full Beatles song," Persky laughed).

Indeed, there's an interesting book called *Floppy Disk Fever: The Curious Afterlives of a Flexible Medium*, which includes interviews with people who continue to work with the medium whether for archiving or even for distributing films. Someone's even managed to squeeze a movie into the available 1.44MB of space, and Persky loves Nick Gentry's disk-based artworks ("you've got to mention him," Persky insisted – check the website at **nickgentry.com**).

"I've never had a Japanese government customer," Persky continued. "But I do have Japanese customers who are preserving old games or using the disks for music devices or pianos. I've also had governments contact me around the world, mostly in the US. I always ask people what they intend to use the floppy disks for because I want to be able to sell more of them."

In general, he added, customers fall into one of three categories. "There are the hobbyists who are trying to preserve old mediums or old games and software," Persky explained. "They're trying to keep their Amiga computers going. Then there's the group of industrial users – the people who bought machines that require floppies to get information in and out.

> "No-one has made a floppy disk in the world for the last decade, so most of the floppy disks I sell are those found in closets"

"If you were an embroidery business and wanted a name on a T-shirt, you'd have to tell the embroidery machine what the font is and what the words will be and you do this using a floppy disk. Those machines were built to last for 50 years and they're still working. Tool and die machines are similar.

"Finally, you get people who want floppies for art projects or for promotions. When two nerds get married, they may want a wedding invitation on a floppy disk, and there are people at conventions who use a floppy disk as a convention badge, especially if the theme is technology."

Cost of living

Among those from the first category are developers of games for old home computers. When an Amstrad CPC version of *Pinball Dreams* was released in 2019, for example, it was

POPULAR Computing WEEKLY

35p 18 November 1982 Vol 1 No 31

This Week

News Desk

Sony launches micro-drive

Micro-drive awaits application

Computer Swap 01-930 3266

WE GIVE YOU MORE—EVERY THURSDAY

Popular Computing Weekly reveals Sony's new 3.5in floppy drive.

Many buyers ask for specific brands such as Verbatim and Maxell.

If you use an old computer you may want to grab some more floppies.

available on a 3in floppy in limited numbers, while Protovision, which was founded in 1996, continues to create and sell titles for the Commodore 64, routinely making them available on floppy disk as well as for download.

"We source the disks mostly from eBay," said Jakob Voos, organiser and coder at Protovision. And here's the thing. Although floppy disks are still available to buy, most of them are second-hand. "A lot of people selling on eBay are likely those who have found 100 disks in their closet," said Persky. "The reality is that no-one has made a floppy disk in the world for the last decade, so most of the floppy disks I sell are those found in closets and old stock rooms."

Some of these are "new old stock" – disks that have never been used and may even come in shrink-wrapped packs – but they're few and far between. "If I get 200 disks, I may find two or three packs of new disks in there," Persky revealed. They tend to sell for a smidgen more than the used ones, but the prices are not generally excessive.

In fact, costs average between $1 and $1.50 for a 3.5in or 5.25in floppy, with only the 3in varieties tending to go for much more. Interestingly, Persky doesn't sell these ("there isn't a demand"), but if you still have an Amstrad CPC or PCW and want to snap one up, then expect to pay more than $4. As you can imagine, there's some money to be made if you have a few blanks knocking around.

Floppy flops

Even so, there are some obvious questions given that the market is so reliant on second-hand disks. For starters, how long do floppy disks actually last? Are you at high risk of buying a dud? Is there a distinct advantage in buying "new old stock"? After all, if you're buying a blank then you're likely going to be entrusting it with your data. You don't want to lose what you save. You need to have trust.

> "According to a 2005 report in the *New York Times*, 3.5in floppies were estimated to have a lifespan of just ten years so long as they were handled and stored with care."

As expected, the answers to these questions are far from clear cut. You could easily grab a floppy from 30 years ago and load it without a hitch on a retro computer – and your correspondent has done that many times over. In the experience of Tokyo official Yoichi Ono, floppy disks are reliable. They "almost never broke or lost data," he told Nikkei Asia in 2021.

But, according to a 2005 report in the *New York Times*, 3.5in floppies were estimated to have a lifespan of just ten years so long as they were handled and stored with care. Christian Bartsch, who used to work for Cachet Software, maker of the infamous Amiga disk-copying program X-Copy, also points to issues.

Among the most notable is deterioration of the data itself thanks to bit rot and the repelling of densely clustered magnetic charges. "The magnetic particles realign themselves to reach equilibrium," Bartsch explained. "This is the so-called digital cliff. Once too much data has become ambiguous, it's impossible to determine its original state."

Persky has an immediate response. "Nothing's forever, right? People think CDs last forever but they don't and, if you're comparing USBs and floppy disks, I'd take a floppy every time," he said. "It's not uncommon for me to have a USB flash drive fail one time out of 20 or 30 but that's not going to happen with a floppy disk."

So why are experiences so varied? It would seem that the type of disk being used could make a difference, with anecdotal evidence suggesting 5.25in disks are relatively robust. "We run a service where we take information off a floppy disk and send it to people, and there was a government entity that stored information on 5.25in floppy disks," Persky said. "It sent 130 5.25in floppy disks written in 1990 and we were able to recover all the data from 127 of them. I defy you to do that with a USB drive, CD or DVD."

Yet it may also be the case that 3.5in disks are less reliable. "We have a good stock of 5.25in disks and they are much less error-prone than 3.5in disks in our experience," said Voos. "The old stock we use functions well and, even after many years, the disks do not lose data."

Given Protovision will sell between 100 and 300 copies of its titles, with its flagship game, Sam's Journey, having sold about 1,500, the company's experience is vast. "I have 5.25in disk originals that are more than 35 years old and there are no issues with any of them. Never did any of the disks fail," Voos continued. "But my experience with 3.5 in disks is much less encouraging, especially with DD disks, for

which fail rates are way more than 50 percent after two decades."

Such a figure for 3.5in disks may set alarm bells ringing but, again, it's difficult to draw any particular conclusion. "It is correct that disks are deteriorating but this has to do with factors such as heat and humidity, with mould being the worst enemy," said Bartsch. "Also, disks with a lower density tend to work much longer – we usually get good reads for properly stored 8-bit disks (for example C64, Apple II and so on), but 1.44MB HD from the mid-90s tend to fail way more often."

Insert disk

So what should you do if you have a stash of floppy disks in a cupboard or a loft? Well, if you're worried that you could lose any data stored on them, you may want to go and retrieve them as soon as you finish reading this article. What you do from that point will then depend on the disk type and format and how you want to make use of those disks.

Perhaps the most straightforward way to view a disk's content is to run it via its original retro hardware. In this situation, you could take an Amiga-formatted 3.5in floppy and insert it into an Amiga computer. So long as the drive is working and the disk hasn't corrupted, you should be successful.

Another way is to grab a working floppy disk drive and connect it to a modern computer. Windows 10 and 11 support the floppy disk format, and you can buy cheap USB 3.5in floppy drives online.

Simply plug one in and insert a PC-formatted 3.5in floppy disk and you'll be able to access its files, perhaps retrieving those old WordPerfect documents you'd long forgotten about (rename the .wpd files to .doc and launch them in Word). Other files can be converted using zamzar.com or viewed by running them via the x86 emulator DOSBox (**dosbox.com**). A quick search online usually gives a good steer.

The situation is trickier regarding 5.25in or 3in floppy drives, however. You can't buy USB versions of these so you'll have to find a used device. Trouble is, connecting these drives isn't straightforward so, if you've got a bunch of Commodore 64 or Amstrad CPC files on 5.25in or 3in disks, for instance, you're going to have to delve a little deeper both in terms of the process involved and your pocket.

One thing's for sure: if you have 3.5in floppies containing data created on an Amiga, Atari ST, Archimedes or myriad other retro machines you can't just insert the disk into a USB drive and expect a PC or Mac to recognise the files. The trick is to sit a device between the drive and your computer that will help make sense of the disk's content.

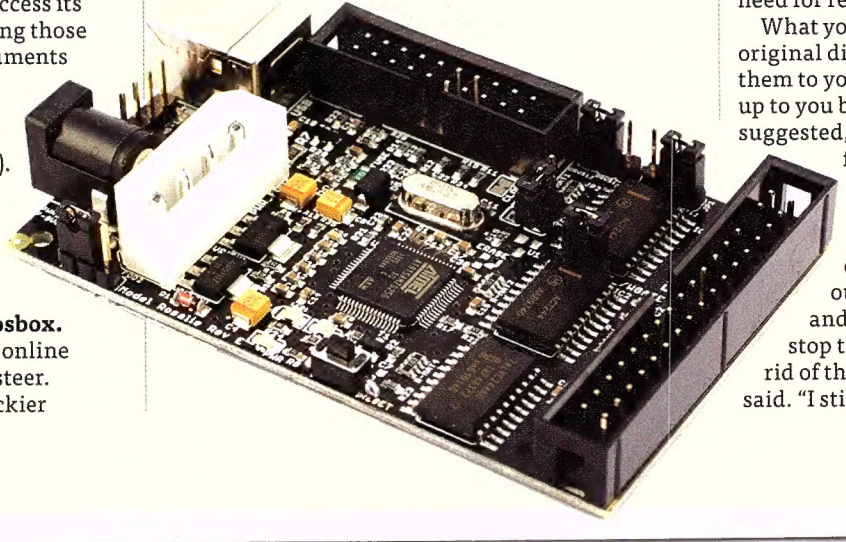
BBC-FDC is one such device – a floppy disk interface that not only allows a drive to be connected to Raspberry Pi but controls it so retro-formats can be read. Then there's KryoFlux (**kryoflux.com**), a floppy controller for PC and Mac that's popular with archivists, allowing for the reading of 3in, 3.5in and 5.25in floppy disks created for many older machines.

Bartsch is KryoFlux's CEO and says his device has rescued an abundance of data over the past decade that may otherwise have been lost. But KryoFlux is not cheap. A basic edition that includes only the board costs €105 and, if you want the required cables and PSU, you'll pay an extra €50. For those with hundreds of old disks, however, it could be worth the investment.

Getting set up with KryoFlux is a matter of plugging the board and drive into a computer and running the software to create disk images. The resulting files can then be run via retro emulators on a modern machine, and it's a solution that can give you a link to the past without the need for retro hardware.

What you then do with the original disks after you've copied them to your PC or Mac is entirely up to you but, as Persky has suggested, you're likely to have few problems selling them. Just don't offer them to the Japanese government. Kono is determined to stamp out their use in Japan, and he's not even going to stop there. "I'm looking to get rid of the fax machine, too," he said. "I still plan to do that." ■

Welcome to floppydisk.com the world's largest supplier of blank floppy disks.



The KryoFlux sits between a computer and a floppy drive.

CHIP CHAT

JOEL BURGESS REPORTS ON THE UNUSUAL SIDE OF TECH NEWS

SHOWCASE HOLOGRAM PC SIDE PANEL

Fill the hollow of your PC with holograms.

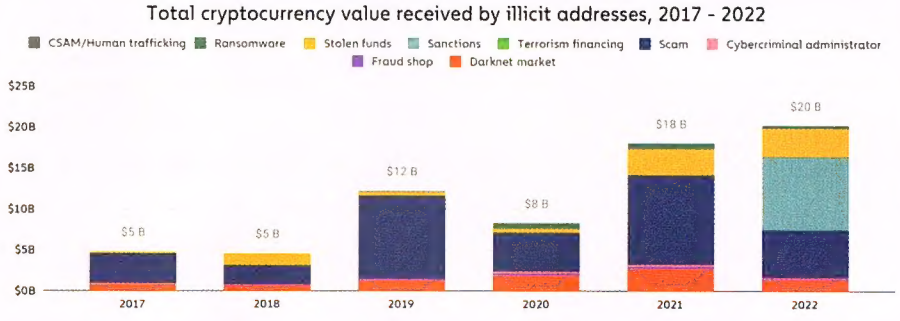
RGB is so 2017, according to one 2023 CES attendee that was showing off PC case panels that could project holograms in the dead space of your rig. Whether it was a *Jurassic Park* T-rex running or a MSI dragon setting all your internal components ablaze, this neat retrofittable holographic panel has made the inside of a PC exciting once again. The handful of tech reviewers that covered them at the event were all impressed with the brightness and quality of the displayed animations, so hopefully the small US-based company will make them available soon.

© Apple

APPLE AIRPODS CAN HELP YOU HEAR CONVERSATIONS CLEARLY

Apple Live Listen allows you to amplify audio sent to your headphones.

If you're having trouble hearing conversations and your hearing aids are amplifying unimportant noises too much, it might seem like you have no option but to just exist in silence. One lesser known feature of iPhones and iPads called Live Listen allows someone to talk into the microphone of the smartphone or tablet and have the audio amplified and transferred to your AirPods or Beats Headphones. Simply connect your headphones, go to settings > control centre and then tap the plus button next to the 'Hearing' icon. There should be an ear icon in your quick settings that you can quickly toggle by swiping down from the home screen.



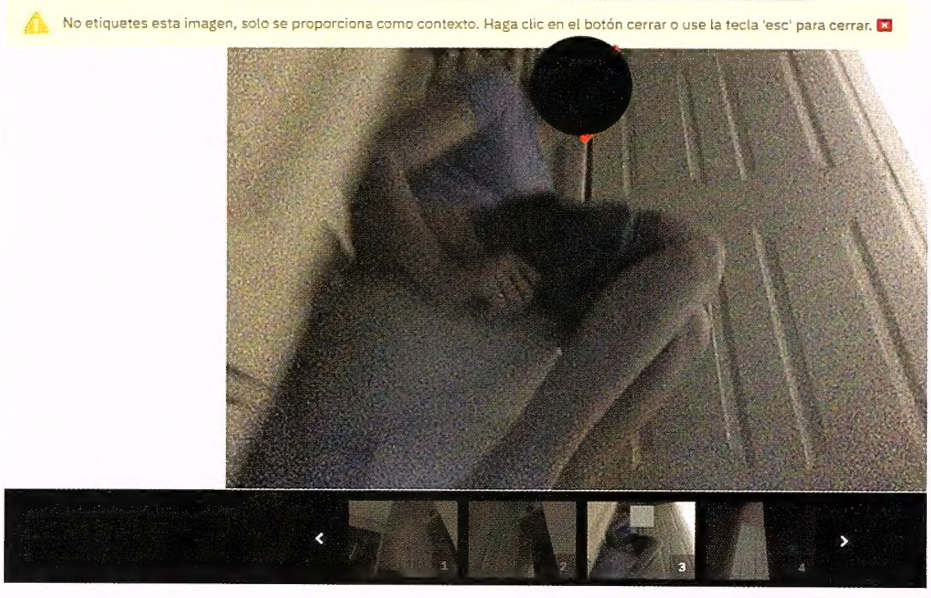
© Chainalysis

CHIP CHAT

US$20Bn worth of illegal crypto transactions in 2022

Chainalysis says crypto was used more than ever last year for dark transactions.

Many still believe that cryptocurrencies are a good exchange for criminal activity because they are untraceable, but Chainalisis has been working for the better part of the last decade to develop software that easily tracks money flow through the public blockchains. Each year it estimates the total value of cryptocurrencies used in known criminal activity and 2022 was a boomer even when the company excludes transactions from potentially criminal activities of collapsed crypto companies like FTX. The total estimate was around US$20Bn, with 44 percent of the transaction volume coming from operating sanctioned entities, around 30 percent from hacks and 20 percent from scams.



© MIT Technology Review

THE ROOMBA NUDES

iRobot vacuum collected sensitive images of testers and shared with third parties.

A beta tester for iRobot's Roomba J series autonomous vacuum cleaners told *MIT Technology Review* that the company's labelling contractors shared non-anonymised images of participants on the toilet to public social media platforms without their knowledge or consent. In a response to the investigation on LinkedIn, iRobot CEO Colin Angle, blamed the third party image annotation provider for the sensitive images leaking and announced it would terminate its relationship with the company, but at least 11 participants deny that iRobot made it clear enough to them the privacy risks they were signing up for.

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Congratulations to the award-winning tech brands that took out honours in the 13th annual Mozo People's Choice Awards

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